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TECHNIQUES OF ANALYSIS IN CONSTRUCTING THE ACADEMIC HIGH-SCHOOL COURSE

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There are two techniques for analysis of curriculum materials which are easy to contrast, because they appear to work in opposite directions. These two techniques may be distinguished as "functional analysis" and "content analysis." Functional analysis has been extensively applied to the construction of many types of curricula and is quite familiar.[1]

Content analysis here designates a modified form of the functional-analysis technique, a form in some respects better adapted to the reconstruction of academic high-school courses.[2] During the past two years, this term has been applied under the writer's direction to studies of the reconstruction of some twenty-four high-school courses in English, foreign language, social science, natural science, and mathematics. In the course of these applications the technique of content analysis has been developed to the point where certain of its advantages are clearly apparent.

Even the student of technique as such cannot be expected to read the description of a method if it is not illustrated by applications and results. Since in the present instance such illustration would necessitate the presentation of several studies, Table I

[1] The term is applied to the technique developed by W. W. Charters and presented in his *Curriculum Construction* (New York, Macmillan Company, 1923. 352 pp.)

[2] A more detailed description of content analysis will be found in Waples, Douglas, "Partial Reconstruction of the High-School Course of Study," *School and Society*, 20:56-59, July 12, 1924.

TABLE I. LEVELS ON WHICH THE CONTENT OF HIGH-SCHOOL COURSES MAY BE ORGANIZED

	English	Foreign Language	Social Science	Science	Mathematics
I. Activities					
a. As learned on the job out of school	Oral speech, written names, and simple sentences	Pronouncing foreign names and discussing racial characteristics	Discussing and taking part in social activities in school and out of it	Use of mechanical devices	Use of applied arithmetic, counting, and discussion of measurement, etc.
b. As selected by classroom conditions	Oral report and recitations, copying, and letter writing	Copying from texts and from dictation, pronunciation	Discussing important social events and customs, school activities	Performing simple laboratory experiments	Making selected arithmetical computations for personal use
II. Problems					
a. As representing difficulties in life activities	How to speak and write clearly	How to translate and compose easy passages	How to explain social-civic conditions	How to repair mechanical devices	How to meet difficulties in computation
b. As typical of problems met in subject as a whole	How to interpret literature and to write correctly	How to translate classics and compose correctly	How to interpret historical events and tendencies	How to solve typical problems by experiment	How to solve typical problems by experiment
III. Principles					
a. As explaining solutions of typical problems	Grammar taught inductively	Syntax taught inductively	Laws of government and of economics taught inductively	Laws of physics, chemistry, and biology taught inductively	Laws of algebra, geometry, and trigonometry taught inductively
b. As constituting the organization of fundamental subjects.	Grammar taught deductively	Syntax taught deductively	Laws of above subjects taught deductively	Laws of above subjects taught deductively	Laws of above subjects taught deductively

is offered as a schematic illustration of a single point of comparison between these two methods. The two techniques, as applied to the construction of academic courses, should be clearly enough differentiated when the statement is made that functional analysis works *down* from activities toward principles, whereas content analysis works *up* from principles toward activities.

In contrasting these techniques the first necessity is an outline of each which may then be illustrated by reference to the table. Such illustration should help to distinguish the purposes for which each technique is better adapted when both are applied to the construction of the academic high-school course.

The successive steps in deriving the academic course by functional analysis may be listed as follows:[3]

1. Compile from all available sources a list of the activities or things which members of a given community must be able to do in order to be socially efficient and to find personal satisfaction in life.
2. Compile a corresponding list of qualities or traits which the individual must exhibit in the efficient performance of these activities.
3. Arrange these activities and traits in order of relative importance for society as determined by the consensus of representative judges.
4. Emphasize such of these activities and traits as are judged to be higher in value for pupils than for adults.
5. Analyze and subdivide each important activity and trait until its elements become sufficiently definite to be mastered by the given group of learners.
6. Eliminate such of these elements as are judged to be learned more readily out of school than in school, thus leaving only the more important.
7. Determine the relative difficulty of these elements from the standpoint of instruction.
8. Obtain from experts in each selected activity the detailed description of methods by which the activity is most efficiently performed.
9. Analyze these methods into their elements and supply such further information as may be needed in order to overcome the difficulties met in attempting to apply the methods specified.

[3] Charters, W. W., *Op. cit.*, p. 102.

10. Classify into "subjects" such of the data reached by the analysis in 9 as are similar and coherent in type, for example, data concerning methods of communication (English), data concerning social practices (social science), data concerning laws of nature (science), and the like.
11. Determine by experiment the relative difficulty and the proper instructional order of the data within each subject. Supply "connective tissue" to relate these data.
12. Construct the course of study by selecting data which are appropriate in point of difficulty and in sequence to the pupils of the given grades.

By referring to Table I the reader will note that these twelve steps may, for sake of brevity, be reduced to three: (1) the collection of life activities, (2) the location of the difficulties or problems which these activities involve, and (3) the collection of methods or principles by which to solve these problems. These three steps will produce, respectively, three types of curriculum material, namely, (1) facts concerning the nature of the activities to be learned, (2) facts concerning the problems to be solved, and (3) facts concerning the methods or principles by which solutions to the problems are reached.

These major steps in the process of functional analysis are indicated by the three horizontal divisions of Table I. These divisions also indicate three levels or stages by which the learner passes from mere contact with the unorganized life activity to the abstract principles of the rigidly organized course. Functional analysis is thus a logical process, for it begins with the primary objectives of any course, the activities to be performed and works back to the abstract principles of advanced courses. These principles which are essential to the efficient and intelligent accomplishment of the activities could never be identified except by means of the problems which arise in performing the activities and which the principles help to solve. Functional analysis is at the same time a psychological process, since the consecutive steps by which the content of advanced courses is derived are also the steps which the learner must take in order to derive full benefit from these courses. The three levels of the table are intended to emphasize this important feature of

functional analysis, namely, that the sequence of these main steps in the process is both logical and psychological. In other words, the process is efficient as a means both of deriving content for an advanced academic course and of deriving content for a sequence of preparatory courses.

This process, as represented by the table, will be made clearer if one of the academic subjects shown, say social science, is followed through each of the levels. The process thus illustrated in terms of social science will be essentially the same if applied to any other subject.

A course in social science on the first of the levels shown (I. a.) consists simply in association with people, in the performance of those social activities, games, and the like, which give the pupil most satisfaction, and in the informal discussion of them. At the next higher stage (I. b.) the course involves arranging and participating in social organizations and school clubs where the pupil can learn the importance of such organizations as the means of accomplishing desirable results. The course at the second level (II. a.) consists of a series of problems which arise in the activities of any such social organization, whether family, club, school, or the larger organizations of community, state, and nation. The pupil is confronted with these problems in the form of classroom exercises and is expected to discuss their implications from the standpoint of the best interests of the social groups concerned. He thus learns what the major social problems are. At the next higher stage (II. b.) he distinguishes those problems that appear to be most significant in the history of the race, by being introduced to historical and modern examples of these typical social problems and asked to analyze and interpret them. At the third level (III. a.) the pupil begins the systematic study of data from the fields of history, economics, political science, and sociology which suggests solutions for the problems he has found to be inevitable in the conduct of any social enterprise. And finally (III. b.) he takes up the academic subjects of history, economics, political science, and sociology as such, the purpose being to study the collected

evidence in support of the principles which each field contributes toward the solution of social problems.

If the technique of functional analysis, as already outlined, were to be fully applied in an attempt to derive content for a course in history it would prove a monumental task, in comparison with which any curricular study so far undertaken would appear puny indeed. Nevertheless, the success of similar studies on a smaller scale justifies the belief that the task could be successfully accomplished if the project were adequately financed. The investigators would collect from every available source a list of all significant social activities in which pupils and adults of the given community engage. They would then select those activities from the list which the pupil needs to be taught, locate the problems he meets in learning these activities, collect data from literature and from life concerning the best methods of solving these problems, and, finally, construct the academic course in history—if, indeed, they find it necessary to construct it at all—by selecting and organizing the specific historical data which may be found necessary in applying these methods intelligently. The academic high-school course in history so constructed would undoubtedly prove valid and useful. It is, however, equally clear that the process of construction is so extensive and difficult that it should not be undertaken except by a staff of experts with adequate funds at its disposal.

In applying the technique of *content* analysis the already-mentioned process is reversed. The investigator begins with the existing course and proceeds through the nine steps listed later. For greater clearness these steps are presented in the form of directions:

1. Make a detailed topical outline of the course as taught, such that all topics are included on which at most two or three days are spent in the classroom.
2. List these topics according to your judgment in the order of their probable value in real life activities to the pupils at present enrolled in the course.
3. Make a parallel list of typical life situations in which you believe each topic could be most usefully applied. This is best done by translating each topic into the specific difficulties, if any, which mastery of the topic would help pupils to overcome.

4. Submit the parallel lists to other successful teachers of the subject, intelligent persons of affairs, and teachers of other subjects, asking each to check the typical life situations which are considered most important, most frequently met, and most difficult to meet successfully. Also request that any new situations be added which are considered of equal importance for the given pupils.
5. Obtain further ratings of these situations from adults representing the social and occupational groups which the pupils of the given classes are likely to enter. Continue these ratings until a perceptible agreement is reached in the situations checked.
6. Retain in the reconstructed course those topics from the original course for which the parallel situations are most frequently checked as important, frequent, and difficult. Eliminate the other topics of the original course unless these are essential to the adequate presentation of the topics retained.
7. Supply such data not contained in the original course as will better enable the pupil to deal with the parallel situations.
8. Organize the selected situations in problem form and in proper instructional order.
9. Arrange the data supplied together with the data retained from the original course with reference to the selected situations as thus organized.

As applied to the academic course in history the investigator employing this technique would proceed at once to analyze the content of the existing course, for example, the course in United States history. He begins, that is, at the last stage (III. b.) represented by Table I and makes a topical outline of the historical events or tendencies of which the given course consists, for instance, colonization. He then collects as many current social problems as he can which are explained in part at least by the facts of colonial history (III. a.), for example, immigration and the related problems of the bases on which to admit immigrants, assimilation into industry, standards of living, labor supply, religious tolerance, political justice, and the like. Each of these problems is presented in the form of a concrete situation or case. Next the investigator submits this list of situations to judges who are intimately acquainted both with pupils of the given grades and with contemporary social problems. From these judges he obtains a selection of typical social situations which are not too far removed from the pupils' experience to be recog-

nized by them as significant (II. b.), for example, a situation to illustrate the labor complications resulting from industrial exploitation of the immigrant. The investigator may go still farther and select only those situations which a majority of the pupils have actually met (II. a.), such as the situation which portrays misunderstanding between persons or groups with different social customs.

It is seldom necessary for the analysis to proceed farther in the direction of life activities (I. a.), since the units of the original course have already been related to the mental content of high-school pupils. In the remaining steps the technique of content analysis takes the same direction as the technique of functional analysis. In both, the investigator selects data from the given field (III. a.) and organizes these data into coherent units or principles (III. b.) The following parallel outlines summarize the comparison as illustrated by the table:

Functional Analysis	Content Analysis
1. Collect all significant (social) activities.	1. Analyze units of the (history) course into the current (social) problems upon which each unit has most useful bearing.
2. Locate most important, frequent, and difficult problems in the performance of these activities.	2. Select most important, frequent, and difficult problems for the given group of pupils from total list of problems.
3. Select (historical) data pertinent to the solution of these problems.	3. Retain and supplement material from the original course which contributes to solutions of problems selected. Eliminate other material.

Under conditions generally existing in those high schools where revision of curricula is most urgent, the technique of content analysis as previously described will be seen to provide the following important economies: (1) some progress in the right direction can be made even though the analysis is made merely by the classroom teacher but on the basis of careful reading; (2) the teaching problems which constitute the basis of the course can be selected with direct reference to the probable needs

of the particular pupils enrolled in the course; (3) the original course is retained in the program, at least in name, thus reducing the opposition of conservative authorities; and (4) the content of the reconstructed course may be validated to any desired degree, depending upon the extent to which local facilities for research permit the use of functional-analysis technique in collecting significant problems and the data which contribute directly toward their solution.

The distinction made in the table between activities, problems, and principles as constituting the elements of academic courses, may indicate the purposes for which each technique is best adapted. When the given course has been located at the proper level, the investigator collects those activities, problems, or principles which are found to be most usefully mastered by the pupil group concerned. Then if a clean sweep can be made of the existing curriculum in any department, it is clear that functional analysis should be employed wherever possible. Whatever principles are really essential to the mastery of the selected life activities and problems will inevitably be included by this technique. If, however, it can be assumed at the start that the course belongs on the principles level—as would be the case if pupils were already acquainted with most of the significant problems in the given field, for example, English composition—it is clearly best to select those principles directly which contribute most toward the solution of these problems. By so doing the investigator will discover what parts of the original material to omit. The same process would be followed when the course belongs on the problems level. The task would then be to collect those problems which arise in performing the essential activities in the given field, foreign language, mathematics, or general science. For the direct selection of such principles or problems to constitute the basis of the reconstructed course, content analysis is a simpler and often a sufficiently satisfactory technique when compared with the more adequate technique of functional analysis.

Since functional analysis is demonstrably an efficient method of constructing an entire high-school program, it should be employed whenever local conditions and a liberal endowment permit an investigation of such large scope. It should also be employed whenever an academic course lies close to the activities level, as might be the case if a course in psychology, or any other strictly college subject, were to be organized for high-school pupils. Functional analysis would here be indispensable as a means of collecting from the pupils' present experience, those situations in which efficient psychological behavior needs to be pointed out; and to be functional, these situations should be collected without the bias which would result if the content of the college course were merely adapted to high-school pupils. Yet most curricular studies are undertaken in emergencies; such as those to determine whether a given course should be dropped or retained in the program for certain groups of pupils, whether certain courses might not be advantageously combined, whether the content of a given course, or certain units of the course, need reorganization to make them more teachable, and the like in each department. For the purpose of supplying first aid to such defects in the organized content of particular departments and courses, content analysis provides always a useful expedient and is frequently an economical and efficient substitute.

IMPROVING COMPREHENSION ABILITY IN SILENT READING

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A review of the experiments which have already been conducted in the field of silent reading seems to indicate that while comprehension has been recognized as the most important factor in reading ability, a large majority of the experiments thus far reported have dealt with other phases of reading. This has been due to two causes: first, up to the present we have had no silent-reading test which purports to single out and measure comprehension; and second, since it is easier to make improvement in speed rather than in comprehension, most of our earlier experiments in silent reading emphasized speed with the hope of improving comprehension ability as a by-product.

Before attempting to set up definite exercises for the improvement of comprehension ability, one must first analyze it into its elements. In the present experiment—one which continued for two years and had for its aim the improvement of comprehension ability in silent reading—two methods of attack seemed plausible. First, the papers of a large number of children who scored high in comprehension ability might be selected and analyzed to determine the factors present. The papers of pupils who scored low in comprehension ability might then be studied in order to find the objectionable factors which kept them from getting a standard score.

One does not have to delve deeply into the literature of silent reading to find that up to the present most investigators have been interested in the child who fails to comprehend rather than the one who scores high on comprehension. After searching in vain for a study which analyzed the ability of those children who scored high in comprehension, it was decided to attack the problem from a remedial point of view and base the experiment on

previous investigations which indicated the factors that prevent children from scoring up to standard in comprehension.

The lack of a wide range of notions and the need of a vocabulary capable of stimulating proper reactions have been recognized by many writers as the cause of low scores in comprehension. Thorndike, Gray, Pressey, and Hilliard[1] have emphasized this fact in previous investigations. It was decided, therefore, to use as one of the exercises some type of drill work which would enlarge the child's reading and understanding vocabulary.

A second type of difficulty mentioned by many writers is the lack of power to select the most important ideas and arrange them logically according to the chief purpose underlying the entire discourse. Data presented by Germane, Woody, and Thorndike led the writer to choose organization as his second type of exercise.[2]

The ability to comprehend what is read is of little value unless one has the ability to retain and reproduce the important thoughts when the occasion demands. Yoakam[3] gives data to prove that the ability of the average child to reproduce what he has read varies from 7.5 percent in grade IV to 20.9 percent in grade VIII. In other words, Yoakam found that the average elementary-school child was only able to reproduce approximately 10 percent of the ideas presented in a piece of factual

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[1] Thorndike, E. L. "Reading as Reasoning," *Journal of Educational Psychology*, 8:323-32, June, 1917.

Gray, W. S. "Principles of Method in Teaching Reading, as Derived from Scientific Investigation," *Eighteenth Yearbook of National Society for the Study of Education*. Bloomington, Illinois, Public School Publishing Company, 1920. Part II, p. 28.

Pressey, L. W. and Pressey, S. L. "A Critical Study of the Concept of Silent Reading," *Journal of Educational Psychology*, 12:25-31, January, 1921.

Hilliard, George H. *Probable Types of Difficulties Underlying Low Scores in Comprehension Tests*. Iowa City, Iowa, University of Iowa, 1924. 60 pp. (Studies in Education, Vol. II, No. 6)

[2] Thorndike, E. L. *Educational Psychology*. New York, Teachers College, Columbia University, 1918. Vol. II, p. 151.

[3] Yoakam, G. A. "The Effect of a Single Reading," *Twentieth Yearbook of the National Society for the Study of Education*. Bloomington, Illinois, Public School Publishing Company, 1921. Part II, p. 90.

discourse after he had read the material once. An exercise to improve retention ability was selected as the third type of drill work.

The three types of exercises finally chosen for experimentation were:

Vocabulary exercise.—To enlarge the child's reading and understanding vocabulary.

Organization exercise.—To train the child in selecting central paragraph thoughts and organizing them logically according to the writer's purpose.

Retention exercise.—To improve the child's ability in retaining and reproducing important thoughts which he had read.

The problem finally selected for experimentation may be stated as follows: (1) Under normal classroom conditions, is it possible to improve comprehension ability by drilling on one of the three types of exercises? (2) What is the relative value of these exercises when used under normal classroom conditions? (3) What would be the effect on comprehension if these three exercises were used collectively according to their relative value?

In order to answer these three questions it was necessary to carry on two distinct experiments. The first was conducted in the school year 1922-23 and the second in 1923-24.

First Experiment

Seventy-five teachers who had been selected because they were especially interested in reading problems worked with the Bureau of Cooperative Research, Indiana University[4] in this study. A total of 3,201 pupils in grades IV to VIII was thus gathered; 1,010 worked on the vocabulary exercise; 1,208, on the organization exercise; and 903, on the retention exercise. The children were divided into drill and non-drill groups by their scores on the Thorndike-McCall Reading Scale, Form I. The first group

[4] These teachers were employed in the following cities: East Chicago, Frankfort, Lebanon, Mishawaka, Huntington, and Indianapolis. The author was Professor of Education at Indiana University from 1922 to 1925.

was drilled on the exercises while the other was taught by the traditional method.

In teaching the vocabulary exercise to the experimental group most of the material used was of the factual sort found in school readers, geographies, arithmetics, and histories. Difficult words were not pointed out in advance; the child was permitted to encounter each word in its natural setting. If in reading a sentence the child was unable to get the idea, because he did not know the meaning of a certain word, he at once wrote this word in his notebook since it was his special problem. By the help of the dictionary he placed after each word a simple definition of the root meaning, a synonym, and several sentences illustrating ways in which the word might be used. If the word proved troublesome to several pupils, it was discussed in class by the teacher. In such discussion the teacher explained not only its meaning as used in the context under consideration but also other ideas which the word might convey when used differently.

The method used in the organization exercise was similar to that just described, but instead of placing the emphasis on vocabulary it was placed on organization. The children were instructed to read the material through carefully for the purpose of outlining the most important thoughts. After this had been done, each child was told to read the material over a second time to correct any wrong impressions which had been formed from the first reading. The class work consisted of revamping the outline under the guidance of the teacher.

The method used in the retention exercise differed from the other two methods, for as soon as the children finished reading the lesson, they took a short, rigorous examination. When they had finished, their papers were exchanged and corrected.

After the class had been drilled for a period of six weeks, the Thorndike-McCall Reading Scale, Form III was given to measure improvement in comprehension. During this experiment,[5] it was necessary to close a few schools for several days

[5] The experiment was conducted during the months of February and March.

because of severe storms. This condition, and sickness in some of the schools, made it necessary to consider only 46 of the 75 classes in the final tabulation. Table I gives the exact number of pupils whose records were used.

TABLE I. THE NUMBER OF PARTICIPANTS

	Vocabulary	Organization	Retention	Total
(1)	(2)	(3)	(4)	(5)
Teachers	16	17	13	46
Pupils				
Drill	259	266	237	762
Non-Drill	252	276	229	757
Total	511	542	466	1,519

TABLE II. AVERAGE SCORES AND THE GAIN MADE BY EACH SECTION ON THE THORNDIKE-MCCALL READING SCALE

	Form I	Form III	Average Gain
(1)	(2)	(3)	(4)
Drill	48.22	54.09	5.87
Non-Drill	46.52	49.27	2.75
Difference			3.12

Table II presents in a rough way the status of the various groups at the beginning and at the end of the six-week period. This table shows that the average child normally makes a gain of 2.75 T-scores on the Thorndike-McCall Scale while those which were subjected to the drill exercises made a gain of 5.87 during this period.

The purpose of this investigation was not only to show the gains made by the groups but also to measure the relative value of each type of exercise. Table III shows the percent of pupils gaining in each type of exercise and the average T-score gain for each pupil in the drill and non-drill groups. From this it appears that while all three types of exercises are beneficial, *Organization* is of most value to the average child, *Retention* is next, while *Vocabulary* is of least value.

TABLE III. PERCENT OF PUPILS IN EACH GROUP WHO GAINED AND THE AVERAGE T-SCORE GAIN

	Vocabulary	Organization	Retention
(1)	(2)	(3)	(4)
	Percent of Pupils Gaining		
Drill	79.5	79.7	65.
Non-Drill	78.9	74.6	64.
Difference	6	5.1	1.
	Average T-Score Gain		
Drill	3.5	5.2	4.5
Non-Drill	3.1	4.	3.6
Difference	.4	1.2	.9

Second Experiment

As stated before, the purpose of the second experiment was to determine how much improvement may be made in comprehension ability when these three exercises are used simultaneously, according to the relative value as determined by the previous experiment.

The method used in the second experiment tried to make practical use of the results of our previous investigation. The three types of exercises were used as in the first experiment. This time, however, they were evaluated according to our previous investigation; the organization exercise was used Monday

and Tuesday of each week, the retention exercise was used on Wednesday and Thursday, and the vocabulary exercise on Friday. It was made clear in the printed instructions that these directions were not to be rigidly followed. If the teacher felt that she could accomplish more by working longer on any one exercise she was permitted to do so. We did insist, however, that the time allotted to each exercise should be according to its relative value.

The classes were not divided into a drill and a check group as in the previous experiment. Each class was tested at the beginning and at the end of the semester by the Thorndike-McCall Reading Scale with the hope of measuring the effectiveness of this type of teaching by checking the results against the normal procedure as recorded on this scale.

The eleven schools[6] which cooperated during our second experiment were smaller than those used in the first experiment. They varied in enrollment from 775 to 3,450. These particular schools were selected, because all of their superintendents had been members of the writer's class in school supervision the previous summer and were familiar with the problem at hand. In order that these superintendents might become even more familiar with the problem, several conferences were held at the university so that each superintendent might have an opportunity to ask any detailed question not answered in the thirteen-page bulletin sent to each teacher.

Some general information which is necessary in order to evaluate the second experiment follows:

Schools cooperating	12
Grades used	IV–VIII
Number of classes	75
Average length of recitation (minutes)	30
Average number of pupils per grade	386
Total number of pupils	1,933

[6] The following schools cooperated: Bainbridge, Bridgeport, Illinois; Hobart, Jonesboro, Knightstown, Liberty, Lowell, North Judson, Onward, Pendleton, Pittsborough, and Thorntown, Indiana.

Table IV gives the *Number of classes* in each grade, the *Standard*, and *T-Scores* for the lower sections of each grade with the scores which were obtained as a result of our September testing. *Grade achievement* gives the reading level of the pupils when the experiment was begun. This indicates that grades VI, VII, and VIII had but fifth-grade reading ability.

Table V is the most significant table thus far. Under *September T-score* it will be noted that the average score for all grades is below standard, while all the grades with the exception of grades VII and VIII were up to standard when the tests were

TABLE IV. RESULTS OF SEPTEMBER TEST

Grade	Number of Classes	Standard	September T-Score*	Grade Achievement
(1)	(2)	(3)	(4)	(5)
IV	15	39.6	36.2	L-III
V	16	44.9	42.2	L-IV
VI	18	50.9	47.0	L-V
VII	14	56.0	49.9	H-V
VIII	12	59.6	50.0	H-V

* All grades were below standard September 17, 1923. Seventy-one of the 75 classes were below standard.

given the second time. Since this was quite contrary to the findings of O'Brien,[7] it seemed advisable to go over the data the second time with the hope of finding the source of difficulty. When this was done it was found that five of the twelve schools were organized on the junior high-school plan, and in these particular schools the silent-reading exercises were given but two days each week. Eliminating these five schools from our tabulation, the data show that grades VII and VIII each gained two semesters. Even with this gain, however, the general average for the classes in grades VII to VIII was below standard.

[7] O'Brien, John A. *Silent Reading.* New York, Macmillan Company, 1921. 289 pp.

If we examine Table V again to determine the number of semesters gained in each semester we shall find that grade v gained least with one semester while grade iv gained most with three semesters to its credit.

TABLE V. AVERAGE GAINS BY GRADES

Grade	Score		T-Score Gain	Grade Achievement		Semesters Gained
	Sept.	Feb.		Sept.	Feb.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
IV	36.2	42.1	5.9	L-III	H-IV	3+
V	42.2	46.3	4.1	H-IV	L-V	1+
VI	47.0	51.0	4.2	L-V	L-VI	2+
VII	49.9	53.8	3.9	H-V	H-VI	2+(2+)*
VIII	50.0	52.8	2.8	H-V	L-VI	1+(2+)*

* The number in parentheses shows the *Semesters gained* when the five schools with junior high-school organizations were eliminated.

TABLE VI. NUMBER WHICH GAINED, LOST, OR REMAINED THE SAME

	Total	Gained	Lost	Same
(1)	(2)	(3)	(4)	(5)
IV	410	349	37	24
V	421	310	77	34
VI	398	285	83	30
VII	402	275	109	18
VIII	302	190	96	16
Total	1,933	1,409	402	122

Out of the 1,933 pupils who took part in the experiment in reading, 1,409 gained, 122 remained at the same reading level, and 402 actually lost in reading ability during the experiment.

When it was discovered that 402 pupils actually lost in reading ability, an attempt was made to locate these pupils with the hope of applying diagnostic and remedial measures. To do this, the scores from each class were arranged in descending order according to the score which each child received on his September test. The gains in T-scores which were made by each pupil

and by quartiles, Q_1 and Q_4, were then tabulated. Table VII indicates that those which gained least were in the upper quartile, while those which gained most were in the lower quartile.

Since superintendents and supervisors are more interested in what happens to the individual child than in average gains made

TABLE VII. GAINS BY QUARTILES

Grade	Upper	Middle	Lower
(1)	(2)	(3)	(4)
IV	3.87	6.29	7.52
V	4.64	4.81	6.08
VI	4.10	4.37	7.57
VII	5.74	4.91	7.35
VIII	2.75	3.09	7.29
Total Gain	4.22	4.69	7.16

TABLE VIII. NUMBER OF PUPILS WHO LOST BY GRADES AND BY QUARTILES

Grades	Q_1	Q_2 and Q_3	Q_4	Total	Total Percent
(1)	(2)	(3)	(4)	(5)	(6)
IV	19	15	3	37	9.2
V	23	48	6	77	19.1
VI	38	39	8	85	26.0
VII	45	58	6	109	27.1
VIII	43	43	10	96	23.8
Total	168	203	33	404	
Percent	41.7	50.3	8.2		21

per grade, Table VI was compiled to show the number that *Gained, Lost,* or *Remained the same* as the result of our semester's drill work.

Table VIII indicates the number of pupils who lost by grades and by quartiles. This table shows that nearly all of the pupils in the lower quartile, Q_4, were helped by this exercise while 41.7 percent of those who failed were in the upper quartile.

Conclusions

The conclusions apply in strictness only to teaching done under similar circumstances. It seems advisable to make the following general statements:

1. Comprehension ability as measured by the Thorndike-McCall Scale may be improved to a degree equivalent to two semesters by careful systematic drill work, covering a period of one semester, provided thirty minutes each day is devoted to the work.

2. Children who scored low in comprehension ability, as measured by the Thorndike-McCall scale, profited more by this type of drill work than did children in the upper quartile.

3. Children of the upper quartile in reading ability should not be subjected to drill exercises but should be permitted to spend more time in using the skill which they have already acquired.

In evaluating a study of this type, several problems should be kept in mind:

1. All the supervision which was accomplished, was done through letters or bulletins. The writer found it impossible to make that personal contact which is so necessary for effective supervision. That supervision was an important factor could be clearly shown in both experiments. In those cases where supervisors and superintendents gave this work their personal attention, the results were most gratifying.

2. The problem of transfer or carry-over is always serious when the experimental and check group are taught by the same teacher. In the rush of teaching, in the first experiment, there may have been a tendency to make one preparation do for both classes.

3. The problem of testing in all experimental work is also serious, and this experiment was no exception. Did the Thorndike-McCall test measure that ability in reading which we were striving to develop or did it measure general reading ability? These questions with many others we are obliged to leave for future investigators.

STANDARD OF LIVING AND STANDARD OF EDUCATING—HAVE THEY KEPT PACE?

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The school expenditures of a community are usually compared from year to year by the *dollars-spent* method. By this method it is estimated that the total expenditures for public elementary and secondary schools in the United States in 1914 were $555,077,000, and in 1924 were $1,808,321,000. There was, therefore, an increase in school costs of 226 percent in ten years. This completes the measurement of school costs by the dollars-spent method, and its simplicity is about its only virtue.

This article suggests another method which measures school expenditures in terms of the *purchasing power per unit of service rendered*. It is believed that this method can be used with considerable advantage in scientific studies of school finance.

That the two methods may give radically different pictures of the trend of school support over a period of years is evident in Figure 1. Between 1914 and 1924, school expenditures increased 226 percent when measured by the dollars-spent method, and 26 percent when measured in terms of purchasing power per unit of educational service rendered. In Figure 1, the line labeled *Index of dollars spent for schools* is based on the following data. In 1914 school expenditures were $555,077,000, according to column *2*, Table I. In Figure 1 this sum, given the value 100, is plotted over 1914 and opposite 100 on the vertical scale. The expenditure of each year succeeding 1914, given in column *2*, is expressed as a percent of the expenditure of 1914, the base year, which is given the value 100. For example, 1916 school expenditures were $640,717,000, an increase over 1914 of 15 percent, which added to 100 gives the expenditure in dollars of 1916 an index value of 115.

For each of the yearly expenditures given in column *2* of this table, an index number was similarly calculated and listed in col-

umn *10*. These index numbers are used in plotting the upper line of Figure 1. If the dollars spent for schools had been exactly the same for each year succeeding 1914 as in that year, the *Index of dollars spent for schools* would not rise as it does but would exactly coincide with the heavy horizontal base line at 100.

The other index line of Figure 1 indicates the purchasing power of school expenditures per unit of school service rendered. This line represents the purchasing power of the money, or the economic power, which school officials commanded in succeeding years for each comparable unit of educational service which they were called upon to provide.

The index numbers used in plotting this lower line are based on calculations which involve: (1) The determination of a unit which may be used in measuring the amount of educational service school boards are called upon to provide in succeeding years. (2) The acceptance of an index of the purchasing power of the dollar, that is, its ability to command human services and material goods, in succeeding years.

The provision of one day's schooling for one elementary-school child is proposed as a satisfactory unit to be used in measuring the amount of educational service provided in successive years. Each day's schooling provided on levels other than that of the elementary school may be weighted on the basis of relative cost. Since it costs approximately two and one-half times as much to provide for pupils attending high schools as pupils attending elementary schools,[1] each day's schooling provided for a high-school pupil is weighted by multiplying by two and one-half in arriving at the total amount of school service rendered.

Thus the amount of service rendered by a school system over a period of years is indicated by weighted aggregate days attendance, obtained by multiplying average daily attendance by the length of the school term, after the attendance in each school

[1] Swift, Fletcher Harper. *Biennial Survey of Public School Finance in the United States, 1920-22*. Washington, D. C. U. S. Bureau of Education, 1923. p. 5. (Bulletin 1923, No. 47)

unit is weighted according to the relation of its cost per pupil to elementary-school costs per pupil. For example, if the aggregate days of schooling provided in a school system were 100,000 and 90,000 of these were days of elementary-school attendance and 10,000 were days of high-school attendance, the weighted

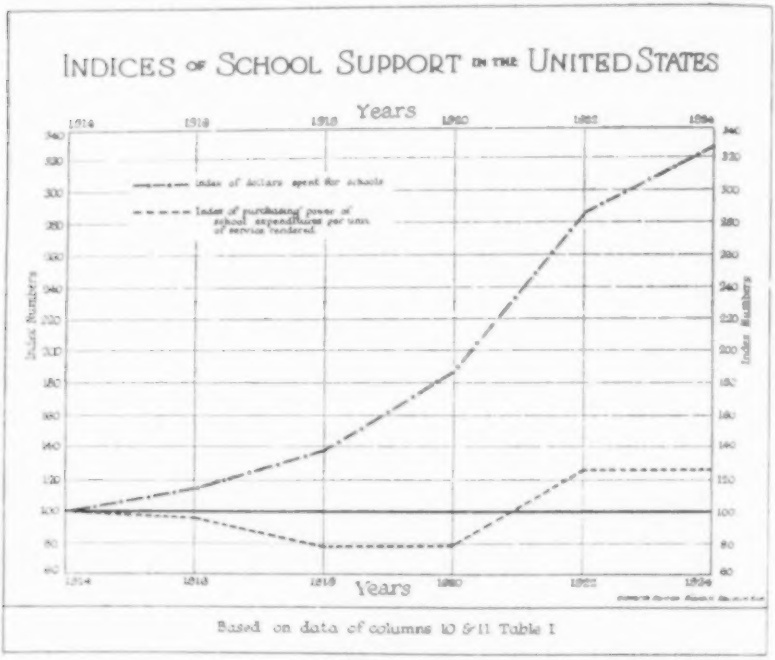

FIGURE 1

aggregate would be 90,000 plus two and one-half times 10,000, or 115,000 in all.

As a basis for determining the purchasing power of the dollars spent by school boards, the index of the cost of living is suggested. If the prices of different goods and services used in the conduct of schools had been properly combined in an index of the "cost of educating," it would be preferable to the cost-of-living index as a measure of the purchasing power of school money. In the absence of such an index that for the cost of

living is employed, although its use involves some questionable assumptions, as a study of the technique of the derivation of index numbers will reveal.[2]

Having decided upon a unit for measuring the amount of school service provided and having adopted the index of the cost of living as a measure of the value of the dollar in succeeding years, it is possible to calculate the purchasing power of school expenditures per unit of school service rendered. This is done for the United States in the succeeding paragraphs.

Table I, column *3*, gives the *Aggregate days attended by public elementary- and high-school pupils* in 1914 and in alternate succeeding years. When the proportion of this attendance, which it is estimated was in high school is multiplied by two and one-half, the figures of column *5* are obtained. These figures are the *Weighted aggregate days attended by public-school pupils* and are suggested as comparable measures of the amount of public-school service provided in the United States in succeeding years.[3]

Table I, column *6*, gives the *Amount expended for each weighted day's attendance*. In 1914, 22.4 cents were expended for each weighted day's attendance, that is, for each unit of school service provided equivalent to the provision of one day's schooling for one elementary-school child. The corresponding figure for 1924 is 46.3 cents. The figures of column *7* indicate, however, that the dollar of 1914 had depreciated to 61 cents in purchasing power in 1924. Consequently, the 46.3 cents expended for each weighted day's attendance in 1924 had but 61 percent as much purchasing power as it would have had in 1914. Sixty-one percent of 46.3 cents is 28.2 cents, the last figure in column *8* of Table I. The other figures of column *8* are similarly calculated. They give the purchasing power of school

[2] *The Cost of Living in the United States.* New York, National Industrial Conference Board, 1925. 201 pp.

[3] These figures refer only to attendance in public elementary and secondary schools. Comparable figures as to the cost of all public education for the years dealt with in this article are not available. Such data as are available indicate that public elementary and secondary schools require approximately 86 percent of the expenditures of all tax-supported schools.

TABLE I. DATA USED IN CALCULATING INDICES OF SCHOOL SUPPORT IN THE UNITED STATES, 1914 TO 1924

School Year	Expended for Public, Elementary, and High Schools (In thousands)	Aggregate Days Attended by Public Elementary- and High-School Pupils (In thousands)	Percent that High School is of Total Enrollment	Weighted Aggregate Days Attended by Public-School Pupils (In thousands)	Expended for Each Weighted Days Attendance (Cents)	Purchasing Power of Dollar on 1914 Base (Cents)	Purchasing Power of Expenditures per Weighted Days Attendance (Cents)	Index of Purchasing Power of School Expenditures per Unit of Service Rendered	Index of School Support Based on Total Dollars Spent for Schools
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1914.....	$555,077	2,255,657	6.36	2,470,847	22.4	100	22.4	100	100
1916.....	640,717	2,461,407	7.15	2,725,393	23.5	92	21.6	96	115
1918.....	763,678	2,498,424	7.89	2,794,112	27.3	63	17.2	77	138
1920.....	1,036,151	2,615,161	10.19	3,014,888	34.4	51	17.5	78	187
1922.....	1,580,671	3,034,907	12.36	3,597,579	44.0	64	28.2	126	285
1924.....	1,808,321	3,224,539	14.01	3,902,176	46.3	61	28.2	126	326

NOTE—

Sources of Data—Columns *2*, *3*, and *4* based on reports of U. S. Bureau of Education.

Column *5* same as column *3*, except that high-school attendance is given two and one-half times the value of elementary attendance. The percent of aggregate days attended by all pupils, which is high-school attendance, is estimated on the basis of the enrollment figures of column *4*, since attendance figures segregated for elementary and high schools are not available.

Column *6* obtained by dividing figures of column *2* by those of column *5*.

Column *7* from *The Cost of Living in the United States*, (National Industrial Conference Board, p. 183), Table 24.

Column *8* obtained by multiplying column *6* by column *7* and dividing the result by 100 to reduce it to cents.

Column *9* obtained by dividing each of the figures of column *8* by 22.4 cents, the 1914 figure of column *8*. The quotients resulting are multiplied by 100.

Column *10* obtained by dividing each of the figures of column *2* by $555,077, the 1914 figure of column *2*. The quotients resulting are multiplied by 100.

expenditures for each weighted day's attendance or unit of service provided.

Finally, the index numbers of column *9* are calculated by adopting as a base the 22.4 cents expended in 1914 for each weighted days attendance and by expressing the other figures of column *8* as percents of this base. These indices of column *9* are used in plotting the lower line in Figure 1, which represents the purchasing power of school expenditures per unit of school service rendered in years between 1914 and 1924. With this explanation of the calculation of the indices of columns *9* and *10* of Table I, we may now compare the trend of these indices in Figure 1.

It will come as a surprise to some that an increase in school expenditures from half a billion dollars in 1914 to nearly two billion dollars in 1924, a 226 percent increase according to the dollars-spent method of calculation, has meant an increase of but 26 percent in the purchasing power of the money expended by school boards per unit of educational service rendered.

The apparent tremendous increases in gross school expenditures are largely swallowed up by the rapid increase in school attendance, particularly in the upper and more expensive levels, and by the depreciating power of the dollar to command human services and material goods. The index represented by the lower line of Figure 1 gives each of these influences proper consideration.

Considering the decade as a whole, there is some justification for the statement that in spite of the continuous and rapid increases during the last decade in gross sums of dollars spent for schools, boards of education were financially no more capable of maintaining efficient schools than they were in 1914.

The ability of school boards to maintain efficient schools is dependent upon the trend of the lower rather than the upper line of Figure 1. Yet it is the upper line of this figure which usually receives the most attention, particularly from the politician interested in selling an economy platform to the people.

It is interesting to compare the trends of the two indices of Figure 1 with school conditions during the last decade. Accord-

ing to the upper line, one would judge that the financial strength of school boards steadily improved throughout this period. The lower line indicates that from 1914 to 1920 the ability of school boards to purchase the services and goods essential to school maintenance decreased, and that only after 1920 did this ability increase.

The lower line corresponds with conditions which have actually existed in the schools. It will be recalled that teachers left the profession by the thousands for other lines of work between 1914 and 1920, that enrollments in teacher-training institutions sharply declined, that school-building programs were reduced to the lowest possible minimum, and that there was a rapid increase in the number of children attending school on half time. A real emergency in education existed during this period, and, had the financial relief of the post-war years not been forthcoming, the public-school system would have been permanently and seriously reduced in efficiency.

Following 1920, the lower curve indicates that the economic strength of school boards has increased and that conditions the reverse of those described above have existed. Some of the teachers who left the profession have returned, normal-school enrollments have increased, and building programs have advanced to the place where part-time sessions are no longer necessary in the schools of many cities.

These facts indicate a closer relationship between the financial resources of school boards and school inefficiency than is generally believed to exist. They offer support for the belief expressed by some students of education that the primary educational problem of the nation is that of securing adequate financial support for its public schools. Certainly they offer little comfort for those who would substitute for adequate financial support some such intangible force as "the missionary spirit" of the teachers of the nation. This currency has little value when it is offered by school boards to the purveyors of school equipment and the builders of school buildings. Why should teachers be expected to accept it? It is true that a spirit of

service and self-abnegation must always be part of a successful teacher, but this does not mean that people of first-rate ability can be expected to have so little foresight as to go through an extended period of professional training only to find at the end that their services command an economic return too small for a life of culture on a professional level. The enthusiastic advocates of lowered tax rates will probably continue their efforts, but it should be clearly recognized that when so-called economy is achieved at the expense of adequate financial support for the schools, lowered school efficiency is the inexorable result. School boards have as yet found no method whereby two children can be effectively educated for the cost of educating one, nor are they able to secure first-rate teaching service or school-building construction except in exchange for the coin of the realm at its current purchasing value.

There is no room for retrenchment in school expenditures except at the sacrifice of school efficiency. It is true that in 1924 the purchasing power of the money expended per unit of educational service was greater than in pre-war years. This higher level of support is essential, however, if the serious retrenchments of the war period are to be made up. More important is the fact that education has never achieved a level of support in keeping with its importance to the nation's welfare. Greater educational efficiency can be attained only if the United States is willing to invest a fair share of its unequaled store of economic energy in the business of education.

That the nation's wealth is adequate for the task cannot be denied. Vast amounts of economic energy are each year available after generous provision has been made for the essentials of economic stability. The last research bulletin of the National Education Association, *Taking Stock of the Schools*, offers abundant evidence to support this statement. Herbert Hoover in his last annual report which reviews economic conditions in the nation in 1925 stated that "the standard of living of the country as a whole was the highest in our history, and, therefore, the highest in all history."

In the light of these considerations, it seems justifiable to contend that school officials would do well to popularize in the mind of the lay public the concept expressed by the index based upon the purchasing power of school expenditures per unit of

TABLE II. PUBLIC-SCHOOL EXPENDITURES AND COSTS PER PUPIL IN AVERAGE DAILY ATTENDANCE IN CITY A

Year	Expended for Public Schools		Cost per Pupil in Average Daily Attendance			
	Current Expense	Capital Outlay	Elementary	Junior High	Senior High	Special Classes
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1914	$1,542,156	$299,402	$50	$75	$105	$103
1916	1,903,478	365,268	52	78	107	110
1918	2,251,305	416,118	54	81	116	112
1920	3,677,771	638,862	77	112	170	168
1922	4,149,251	998,703	79	115	180	175
1924	4,855,842	1,306,394	85	123	187	190
Average cost 1914 to 1924			$66	$97	$144	$143
Cost ratio with cost per elementary pupil as 1.00			1.00	1.47	2.18	2.17

TABLE III. AVERAGE DAILY ATTENDANCE IN EACH SCHOOL UNIT AND LENGTH OF SCHOOL TERM IN CITY A

Year	Average Daily Attendance—Day Schools					Length of School Term
	Elementary	Junior High	Senior High	Special Classes	Total	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1914	24,242	5,561	1,801	226	31,830	185
1916	29,346	6,395	1,882	387	38,010	186
1918	32,747	7,137	2,099	692	42,675	186
1920	35,241	8,346	2,782	1,163	47,532	188
1922	36,526	10,606	4,002	1,842	52,976	188
1924	37,330	13,614	4,922	2,075	57,941	190

school service rendered—the concept, in other words, which this article develops.

The measurement of school support by dollars spent is almost valueless from a scientific standpoint. The unit of measurement.

upon which it is based, the dollar, seldom has the same value in succeeding years. The size of the educational job, for which the sums of fluctuating dollars are appropriated, changes rapidly. Nor does a statement of dollars spent for schools over a period of years furnish a reliable indication of the trend of the school-tax burden. The $1,808,321,000 expended for public schools in 1924, purchased only as much as $1,103,076,000 would have bought in 1914. This shows how inexact is the practice of

TABLE IV. WEIGHTED DAYS' ATTENDANCE IN EACH SCHOOL UNIT IN CITY A

Year	Total	Elementary	Junior High	Senior High	Special Classes
(1)	(2)	(3)	(4)	(5)	(6)
1914	6,814,155	4,484,770	1,512,314	726,343	90,728
1916	8,126,191	5,458,356	1,748,521	763,113	156,201
1918	9,172,749	6,090,942	1,951,399	851,103	279,305
1920	10,546,441	6,625,308	2,306,501	1,140,175	474,457
1922	12,189,604	6,866,888	2,931,074	1,640,180	751,462
1924	13,789,305	7,092,700	3,802,390	2,038,692	855,523

NOTE—

The figures of columns 3 to 6 are calculated as follows: The aggregate number of days attendance (unweighted) for each year is obtained for each school unit by multiplying the average daily attendance of each school unit as given in Table III by the length of the school term as given in column 7 of the same table. The results (not shown in tables accompanying this article but which may be readily calculated from Table III) are weighted by multiplying by the ratios at the foot of Table II, which represent the relative per-pupil costs in the various school units. That is, aggregate days attendance in elementary schools is multiplied by 1.00; aggregate days attendance (unweighted) in junior high schools is multiplied by 1.47, etc.

using gross sums of dollars spent for schools as indications of the percent of the nation's supply of economic energy which is devoted to education. In short, the trend of the index of school support based on dollars spent for education in itself is of no definite significance.

On the other hand, a rise or a drop in the index of school support based on the purchasing power of expenditures per unit of service rendered has a definite meaning. It indicates whether school officials are in a stronger or a weaker economic position with reference to rendering each unit of educational service de-

manded by the public. At a glance, it tells whether the economic support accorded the schools over a period of years justifies increased or decreased educational efficiency.

An application of the technique described above to an individual city reveals some significant facts. In Tables II to V data are given for City A which closely correspond to the conditions

TABLE V. CALCULATION OF INDEX OF SCHOOL SUPPORT PER UNIT OF SCHOOL SERVICE RENDERED IN CITY A, 1914 TO 1924

Year	Expenditures for Each Weighted Days Attendance		Purchasing Power of Dollar on 1914 Base	Purchasing Power of Expenditures for Each Weighted Days Attendance		Index of School Support for:		Index of School Support Based on Total Dollars Spent for Schools
	Current Expense (Cents)	Capital Outlay (Cents)	(Cents)	Current Expense (Cents)	Capital Outlay (Cents)	Current Expense per Unit of Service Rendered	Capital Outlay per Unit of Service Rendered	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1914	23	4	100	23	4	100	100	100
1916	32.5	4.5	92	22	4	96	100	123
1918	24.5	4.5	63	15	3	65	75	145
1920	35	6	51	18	3	78	75	234
1922	34	8	64	22	5	96	125	280
1924	35	10	61	21	6	91	150	335

NOTE—

Column *2* is obtained by dividing amount expended each year for current expense (column *2*, Table II) by weighted days' attendance for each year as given in column *2*, Table IV.

Column *3* is obtained by dividing amount expended each year for capital outlay (column *3*, Table II) by weighted days' attendance for each year as given in column *2*, Table IV.

Column *4* from *The Cost of Living in the United States*, National Industrial Conference Board, p. 183, Table 24.

Columns *5* and *6* are obtained by multiplying columns *2* and *3* respectively by column *4*.

Columns *7* and *8* are obtained by dividing each of the figures of columns *5* and *6* by 23 cents and 4 cents respectively, the 1914 figure of the column concerned. The results are multiplied by 100.

Column *9* is obtained by dividing the total expenditures for schools for each year (current expense plus capital outlay) columns *2* and *3* of Table II, by the total expenditures for 1914 (current expense plus capital outlay, or $1,841,558). The results are multiplied by 100.

that existed between 1914 and 1924 in one of the rapidly growing cities of the United States. The methods used in calculating the indices of columns *7* to *9* of Table V are substantially the same as those described above for calculating corresponding indices for the United States. These differences, however, should

be mentioned. Total school expenditures are segregated under two heads: current expenses and capital outlay, and four rather than two school groups are distinguished in weighting aggregate day's attendance. The attendance of each of these four groups, elementary, junior high school, senior high school, and special

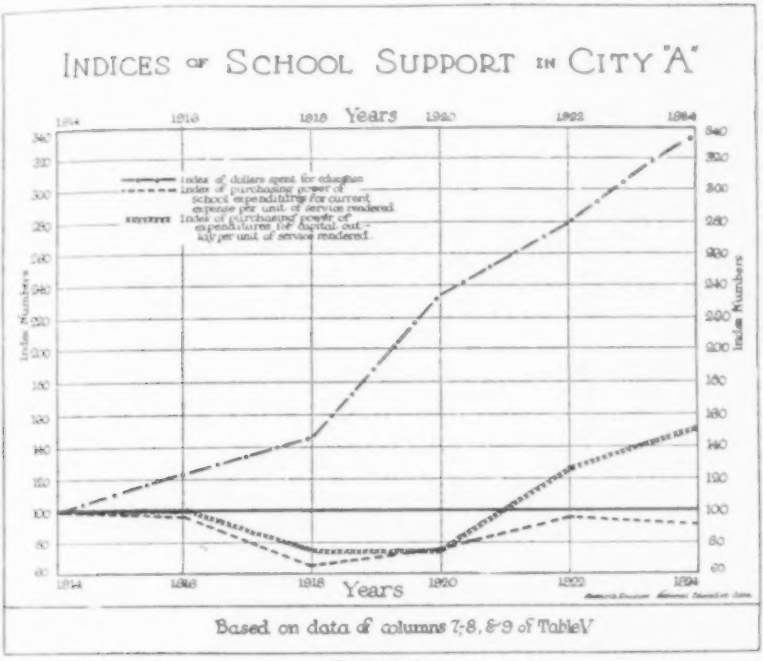
INDICES OF SCHOOL SUPPORT IN CITY "A"
Years
Index Numbers
Index of dollars spent for education
Index of purchasing power of school expenditures for current expense per unit of service rendered
Index of purchasing power of expenditures for capital outlay per unit of service rendered
1914
1916
1918
1920
1922
1924
Based on data of columns 7, 8, & 9 of Table V

FIGURE 2

classes, is weighted according to their relative per-pupil cost as indicated in Table II. The other calculations of these tables that are not apparent are explained at the foot of Table V.

Figure 2 depicts the three sets of index numbers of Table V, columns 7 to 9. This diagram should be interpreted in the same manner as Figure 1, the significance of which has already been explained, except that instead of a single line to indicate the purchasing power of school expenditures per unit of school

service rendered, it presents two such lines, one for current expense, the other for capital outlay.[4]

Figure 2, if one considers the upper curve, the index of dollars spent for education, seems to indicate a steady and rapid increase in the financial support of the schools in City A. The other two index lines tell a different story.

In no year since 1914 has the purchasing power of current expenses per unit of school service rendered been as great as it was in 1914. The items of current expense are probably the most significant in determining the efficiency of a school system. They include such vital factors as the cost of administration and instruction. On the other hand, in City A the purchasing power of the money available for capital outlay per unit of service rendered has been substantially higher since 1920 than it was in 1914.

Does this mean that City A is spending too much for school buildings while the items that go to make up current expense are receiving too little financial support? This question cannot be answered with certainty. A continuance of the tendencies indicated by the index numbers for 1922 and 1924, however, would probably justify this conclusion.

The index of the purchasing power of school costs per unit of service rendered should be useful in scientific budgetary analysis. Too frequently existing budget requests present little else in the way of supporting data than the valueless statement of total dollars spent for schools over a period of years. The index developed in this article can be employed, with reasonable exactness, to show over a period of years the relationship which exists between the purchasing power of the amount requested in a budget and the size of the educational task which a school board

[4] In the calculations for City A it is assumed that the per-pupil cost ratios of the different school units are the same for current expense and capital outlay. The justification of this assumption could be readily ascertained in a city where complete data are available and calculations modified accordingly. The use of an index of building costs in dealing with capital outlay, rather than the index of the cost of living in comparing the purchasing power of the dollar over a period of years, would also be desirable. These and similar desirable refinements of the technique presented are necessarily omitted in an article of this length.

faces. This relationship can be shown not only for the total budgetary request but for individual items such as salaries, school supplies, and building construction.

Summary

Statements of the financial support accorded school systems over a period of years based upon total dollars spent for education are of little scientific value, since they disregard changes in the purchasing power of the dollar and in the size of the educational job to be done.

An index of the purchasing power of school expenditures per unit of school service rendered is developed. This index reveals with reasonable exactness, over a period of years, the relationship which exists between the purchasing power of the sums expended for schools and the amount of service rendered. This index may give a radically different picture of the trend of school support than one based on total dollars spent. In the United States between 1914 and 1924, dollars spent for education increased 226 percent, while school support increased but 26 percent according to the index of the purchasing power of school expenditures per unit of service rendered. The use of this index will offer many advantages in scientific analyses of school budgets.

STATUS OF UNIVERSITY STUDENTS IN RELATION TO HIGH-SCHOOL COURSES

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It is customary for colleges and universities either to require or to recommend certain specific academic preparatory courses. The purpose of this study is to compare the university scholarship record of students who have had specified high-school courses with the record of those who have not met this requirement. The specified courses are as follows: English, three years; United States history, one year; mathematics, two years; physics or chemistry, one year; foreign language, two years; additional mathematics or foreign language, one year; and two additional years chosen from English, mathematics, foreign language, history, natural science, and drawing—a total of 12 specified units.

The report submitted herewith is based on data compiled from the record cards of 369 Freshmen who entered the College of Letters and Science, University of California, Southern Branch, in September, 1923. For the purpose of this study the records of students whose names began with A to L, inclusive, were included with the following exceptions: students with advanced standing, special students, and students who left without receiving first-semester grades. Students' records were included whether or not they were attending the university at the time the study was made. In fact, of the 369 students it was found that 124 or practically one-third were no longer in attendance.

The academic subjects completed in high school were determined by direct comparison of each student's record card with the proposed requirements, that is, with the twelve-unit program described above. On this basis it was found that 203, or 55 percent, of the students had completed the twelve specified academic units. The remaining 166 (45 percent) had fallen short of the specified units in one or more particulars. A record

was taken of the particulars. It showed that these students were distributed as to the incompleteness of their preparation as follows: English, 5 students; mathematics, 10; physics or chemistry, 39; foreign language, 25; an additional unit of mathematics or foreign language, 32; two additional academic units, 13; two of the foregoing items, 33; three of the foregoing items, 9—a total of 166[1] students.

TABLE I. MEAN COLLEGE GRADE IN RELATION TO COMPLETION OF REQUIRED PREPARATORY UNITS

Mean Grade	Number of Students			Percent of Students		
	Requirements Complete	Requirements not Complete	Total	Requirements Complete	Requirements not Complete	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.5 to 3.0 (A)	2	1	3	1.0	0.6	0.8
2.0 to 2.49 (B+)	11	8	19	5.4	4.8	5.1
1.5 to 1.99 (B−)	35	16	51	17.2	9.6	13.8
1.0 to 1.49 (C+)	56	52	108	28.6	31.3	29.3
0.5 to 0.99 (C−)	56	42	98	28.6	25.3	26.6
0.0 to 0.49 (D+)	35	25	60	17.2	15.1	16.3
−0.5 to −0.01 (D−)	5	17	22	2.5	10.3	5.9
−1.0 to −0.51 (E, F, Inc.)	3	5	8	1.5	3.0	2.2
Total	203	166	369	100.0	100.0	100.0
Mean	1.03	0.86	0.95	.....	.....	.....

The university scholarship of the 369 students whose records were consulted was determined on two bases: (1) the average grade in all subjects at the end of the first semester; (2) the ratio of units passed to units attempted during the first semester. In determining the average grade, letters were changed to numbers. Three points were given for an A grade; 2, for a B; 1, for a C; 0, for a D; and −1, for E, F, and incomplete.

Table I shows the relationship between the mean grade received by these pupils and their completion or non-completion of the above mentioned academic requirements. According to this table there was a very slight tendency for students who had

[1] In the above list history does not appear. It was necessary to assume that completion of one year of history satisfied the requirement as to United States history. The records did not indicate the specific course taken. All students had taken one year of history.

completed the accepted 12 units of high-school work to have a better average grade at the end of the first semester. The coefficient of correlation (bi-serial r) was +.20. The real meaning of this is that a prediction of college scholarship based on the completion or non-completion of these required high-school units would be 98 percent of a mere guess.

TABLE II. PERCENT OF COLLEGE UNITS PASSED IN RELATION TO COMPLETION OF REQUIRED PREPARATORY UNITS

Percent of Units Passed	Number of Students			Percent of Students		
	Requirements Complete	Requirements not Complete	Total	Requirements Complete	Requirements not Complete	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
100	132	103	235	65.0	62.0	63.6
95– 99.9	4	2	6	2.0	1.2	1.6
90–	5	3	8	2.5	1.8	2.2
85–	9	2	11	4.5	1.2	3.0
80–	12	15	27	5.9	9.1	7.3
75–	7	5	12	3.4	3.0	3.3
70–	5	3	8	2.5	1.8	2.2
65–	8	9	17	3.9	5.4	4.6
60–	6	2	8	2.9	1.2	2.2
55–	4	6	10	2.0	3.6	2.7
50–	5	1	6	2.5	0.6	1.6
Below 50	6	15	21	2.9	9.1	5.7
Total	203	166	369	100.0	100.0	100.0
Mean	93.3	89.1	91.0	.....	.....	.....

Table II shows the relationship between the completion of the preparatory requirements on the one hand and the percent of college units passed on the other hand. Again the relationship is very slight. The 203 students who had completed the twelve prescribed preparatory units passed 93.3 percent of the college work which they attempted. The 166 students who had not fulfilled the twelve preparatory requirements passed 89.7 percent of their college work. The coefficient of correlation (bi-serial r) is only +.09.

The conclusion is obvious. The data presented seem to indicate a very slight superiority on the part of students who have completed certain specified preparatory requirements. For purposes of prediction, this superiority is practically negligible.

DIAGNOSIS AND REMEDIAL TREATMENT OF POOR SPELLERS

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The writer was notified of twenty-three cases of spelling disability in the Scarborough School, Scarborough, New York. These children were in grades seven to twelve and were doing such consistently poor spelling as to convince their teachers that they were cases of special disability. The term has been used to signify that the individual so designated was "born short." In this study the term disability will not be used to imply that the children were incapable of learning to spell, but simply to mean that their spelling ability at the time was far below the norms for their respective ages and grades. It is the opinion of the writer that many so-called "disability cases" in spelling might have been avoided or corrected had they been skillfully handled from early years.

PRELIMINARY EXAMINATIONS

The inability to spell may be due to sensory defects; for, if sounds are indistinctly heard or if the visual apparatus is faulty, the image is of course distorted. A careful check was made of the sensory equipment of each child, both auditory and visual, and no case of either sensory defect was found.

The degree of intelligence was next determined. No child had an intelligence quotient below 89. The range was from 89 to 142; median, 118. The correlation coefficient of spelling with intelligence is somewhere around .50.[1] It is obvious that the intelligence of this group is sufficient in most cases for better than average attainment in spelling.

The Thorndike-McCall Reading Test, Form 1, was given and the range of T-scores was from 58 to 73; median, 67. In

[1] Hollingworth, L. S. *Special Talents and Defects.* New York, Macmillan Company, 1923. p. 100.

no case was it felt that the inability to spell resulted from inferior reading comprehension.

Procedure

An attempt was made to discover particular individual weaknesses. From the point of view of education as a process of forming correct habits, it was regarded as fundamental to discover the under-learned or incorrect habits which were causing poor spelling. For aid in identifying under-learned or incorrect habits, Miss Alice E. Watson suggested the following diagnostic outline for the classification of spelling habits:

I. Attention to syllables
   A. Rhythmic pattern of word
   B. Differentiation of syllables
   C. Phonic quality of each syllable
II. Establishing a new or unique reaction
III. A. Distinguishing between possible and impossible ways of writing a given sound unit
   B. Spelling particular word-units according to their proper sound-unit categories:
      1. *ie* or *ei*
      2. *os* or *oes* in plural
      3. Change *y* to *i* when suffix is added
      4. Drop silent *e* when suffix is added
      5. *c* and *g* soft before *ei* or *y*
      6. Double consonant when suffix is added
      7. *some* as a suffix
      8. *ment* as a suffix
      9. *ful* as a suffix
      10. *ed* especially when pronounced as "*t*"
IV. Forming letters legibly in handwriting
V. Coordination and motor-control
   (Lapses or slips, reversals of order, omissions, or insertions)

Lists U, V, and Y, selected from the Buckingham Revision of the Ayres Spelling Scale, were given to the children. The dictation exercise, Form A, of the Stanford Achievement Test and one hundred words selected from a classified word list for remedial exercises were given. In addition to this, the compositions and regular written work of the pupils were examined. All the spelling errors, assembled for each child, were listed according to their position in the above diagnostic outline. The child

was then examined orally on the misspelled written words. Consistent oral misspellings were again checked and tabulated according to the outline.

It was found that a preponderance of the errors of each child could be classified under specific habit types. Pupils seemed to have formed definite incorrect habits. They spelled words incorrectly by specific wrong combinations more often than chance would allow.

During the following ten weeks each child was given eight twenty-minute periods of individual instruction with the school psychologist. During the first period, one specific difficulty was taken up. The child was led to appreciate the particular habit at fault and to try to substitute the correct one. Follow-up work for the coming week was then outlined. Another specific habit was taken up at the next meeting with the psychologist, and subsequent drill was again outlined. This was continued until each child had been treated for all his particular types of difficulties. Further opportunity for general improvement was provided by assigning study lists. These lists were made up of words selected from the Thorndike *Word Book*. Most of the children were also given drill in phonetics.

Lists from the Ayres Spelling Scale were not studied by these children during the period between tests. End tests in April consisted of the Ayres Lists U and W. The latter had not been given in December and served as a check upon List U.

In the cases studied the aversion to spelling was universal. Statements such as "I hate spelling," "I can't spell," "It's no use to try to teach me to spell" were typical responses from the group. A large part of success in spelling is determined when one is satisfied only by the correct combination of elements. The question then became: How can one change the attitude of accepting inferior products and of being satisfied by them into one whereby the pupils will have zest for success and interest in producing superior products? If one is able to identify specific types of difficulty for each child, may not this prove an incentive toward increasing the spelling ability of each? Just this seemed to happen. The awareness of specific difficulties actuated the

pupils to correct them. This spirit led to a change in their approach to spelling in general. Possibility of success in hitherto impossible tasks became evident, and out of success in the specific situations, in which they saw underlying principles and real needs, a lively interest developed.

Case Studies

Case P is illustrative of the genesis of the development of this desirable attitude. He is in grade x; I.Q., 118; chronological age, 179 months. His initial attitude was expressed by "I can't spell. I hate spelling. I never have been able to." The following were misspellings from List U of the Ayres Scale: *responcible, cercumstance, essue, recieve, majorety, acheives,* and *apeice. Recieve, acheives,* and *apeice* were classified as III-B-1 of the diagnostic outline, a confusion of ie and ei; *essue* and *majorety* were classed as I-C, failure to recognize phonic quality of syllables; and *cercumstance, responcible,* and *develope* as III-B. The following three categories included seventy-five percent of all errors in the hundred-word dictation list:

Attending to phonic qualities of slurred syllables.

Associating specific word-parts with their proper sound-unit categories.

Forming plural of nouns ending in o.

The identification of the definite bonds to be formed and the specific ones to be broken was now complete enough to begin actual remedial work. In this case special consideration had to be given to the fact that the establishment of the correct bonds and the elimination of undesirable ones may not result from exercise merely. Exercise may need to be reinforced by definite provision for favorable attitudes. The mere identification of their specific difficulties proved of surprising interest to the pupils. *Case P,* after spending thirty minutes with the psychologist discussing his particular weaknesses, asked for further illustrations of his errors and suggested that he keep a daily record of his spelling errors. Contrast this attitude with the previous indifferent one! During the following week the psychologist devoted two twenty-minute periods to him, allowing him

to induce the basic principles involved in the types of errors made. Habits of being constantly alert for new words, of checking written work, tabulating errors, and listing difficult new words were developed in the boy.

In each of the cases studied, the majority of the errors could be classified under two or three specific habit headings. With *Case R*, two factors seemed to be outstanding in determining the spelling difficulty. The last halves of the misspelled words showed many more errors than the first halves. The remedy used was readjusting attention by phonetic drill. Another factor was failure of recognition in recall. Emphasis was placed upon syllabication in an attempt to bring each syllable clearly into attention focus.

Mistakes in spelling may be due to lapses, errors made by individuals who know the words. Two of the inability cases seemed to be due in part to such lapses. Dictation (sentence) exercises were given. Each sentence was checked immediately after completion and errors were tabulated at once. After accuracy was obtained in writing sentences, larger units were written before checking. Finally, whole paragraphs were written and checked at once with the student. The habit of giving careful analytical attention to sound-units when writing words was thus developed.

Case I wrote extremely slowly, with handwriting of very inferior quality and made more errors in written than in oral spelling. Her word forms were very distorted, so that it was difficult to identify words she had written, even when they were correctly spelled. Drill in handwriting was prescribed.

Many of the cases illustrate inadequate attention to syllables. Such mistakes as *flattring, confrence,* and many similar errors were classed as due to faulty rhythmic appreciation while such errors as *flatering* and *regretable* were classified as III-B-6, failure to double the consonant when a suffix is added. In one case, there was a fairly constant error of reversing the order of letters. This case seemed to be also a "letter speller."[2] Corrective

[2] Gates, A. I., *The Psychology of Reading and Spelling.* New York Teachers College, Columbia University, 1922. p. 68. (Teachers College, Columbia University, Contributions to Education, No. 129)

work consisted in careful drill upon hearing, pronouncing, visualizing, and spelling all words in syllabic rhythms.

Case U's mistakes, *lickable* and *desitful*, were classed as III-A, since *lick* could not be recognized as intended to spell the sound-unit *like*, if standing alone, nor could *sit* be pronounced as *scat*. Phonic drills were given, namely, practice in collecting possible ways of spelling some of the commoner English syllables, with subsequent practice in pronouncing these collections of phonograms.

Practically all cases made errors of associating specific word-parts with wrong sound-units. These were classified under the subheadings of the diagnostic outline. The remedial work consisted in leading the child to appreciate the rule and to formulate it for himself. Subsequent drill followed, and the periods for each type gradually decreased in length as the intervening periods grew longer.

Results

The April tests showed a marked improvement in each case. The improvement for the group was shown in a gain from a mean score in December of 61 percent on List U of the Ayres Scale to 85 percent in April. This improvement was substantiated by the standing of the group in List W of the Ayres Scale.

The ultimate criterion of any improvement in specific bonds is: "Do these bonds function correctly when involved in other contexts?" The teachers report favorably on all the cases, and the compositions show marked improvement both in spelling and neatness. It is of interest to note that in these cases there has also been noticeable improvement in the general quality of the compositions. It seems that the mechanization of spelling reactions, with consequent freedom from stumbling over words, and from attending to details of word formation, has occasioned increased facility in the flow of thought, made possible freer attention to meaning, and resulted in a considerable increase in power in the art of composition itself.

A PLEA FOR A STANDARD DEFINITION OF THE STANDARD DEVIATION

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Statistical science has had such a rapid development in the past few years that it is not surprising to find a lack of uniformity in some of the terms and measures employed. It seems particularly unfortunate, however, that there should be a lack of uniformity in the definition and use of the common measure of dispersion, *standard deviation*. Standard deviation ought to have a standard meaning for statistical workers in all fields: it should have the same meaning for the pure mathematician, the biologist, the economist, the psychologist, and the educator.

For thirty years it has enjoyed a uniqueness of definition and use among statistical authorities and workers in the fields of biology, sociology, economics, and pure mathematics. But unfortunately in the more recently developed and developing fields of educational and psychological statistics this is not the case. Beginning with Thorndike twenty years ago, and more particularly exemplified in a half dozen very excellent educational statistical manuals which have appeared in the past few years, it is found that the standard deviation is variously defined so as to mean any one of at least three different things.

Perhaps Yule's definition is as well known and satisfactory as any:

> The standard deviation is the square root of the arithmetical mean of the squares of all deviations; deviations being measured from the *arithmetical mean*[1] *of the observations.*[2]

For this he adopts after Pearson the notation σ. He also defines "a quantity analogous to the standard deviation," the "root-mean-square" deviation, from any origin A, and adopts for it

[1] *Italics* in quotations throughout this paper were set by the author of the paper, not by the authors quoted.

[2] Yule, G. U. *Introduction to the Theory of Statistics.* (5th edition) London, Charles Griffin and Company, 1919. p. 134.

the notation *s*.[3] That is to say, the standard deviation is the particular "root-mean-square deviation" which is *measured from the mean*. These are perfectly definite concepts and as will be shown later these definitions are taken in this sense by all the leading statistical authorities except those in the field of education.

Educational Authorities

Thorndike, in the first edition of his pioneer manual, says:

> The mean square deviation *or the standard deviation* equals the square root of the averages of the squares of the deviations of the individual measures *from their average, median, or mode*.[4]

He uses σ indifferently for any of the three different measures thus defined and gives detailed instructions for computing it from the median and from the mode as well as from the average. In the revised edition of the same work, he says:

> The mean square deviation is sometimes called the standard deviation, though its right to be considered a standard measure of variability is by no means secure. Standard deviation, σ, or mean square deviation will be used indifferently to refer to it throughout this book.[5]

He gives several examples of standard deviations computed from the *mode*, *median*, and *average*.

Whipple defines the standard deviation σ, as "the square root of the average of the squares of the individual deviations"; where deviations are defined on the previous page as measured "from their mean, M (*or some other measure of central tendency*)." In discussing the coefficient of variability, he states that it may be computed "by dividing . . . . a measure of variability by a representative measure, that is, *either S.D., A.D., or P.E.*, may be divided *by either mean, median, or mode*." And in computing the Pearson coefficient of correlation he says to compute deviations from *either mean or the median*.[6]

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[3] Yule, *op. cit.*, p. 134. This is referred to more briefly by other authors as a "mean square" deviation.

[4] Thorndike, E. L. *An Introduction to the Theory of Mental and Social Measurements*. New York Teachers College, Columbia University, 1904. p. 38.

[5] Thorndike, E. L. *An Introduction to the Theory of Mental and Social Measurements*. New York, Teachers College, Columbia University, 1913. p. 39.

[6] Whipple, G. M. *Manual of Mental and Physical Tests*. (2d edition) Baltimore, Warwick and York, 1914. pp. 21, 22, 25, and 38.

Buckingham says, "The standard deviation . . . . is found by squaring the differences between the individual measures and the C. T." where he has already defined "C. T." (central tendency) as "the average, or arithmetical mean, the median, and the mode."[7]

McCall, in his recent excellent manual, also says, "The standard deviation may be computed from *any average*, or measure of central tendency, whether mode, median, or mean,"[8] and he devotes a paragraph to the computation of it from the median.

Others omit the mode but allow the standard deviation to be computed from the mean or median. Thus Wilson and Hoke speak of "the standard deviation from the arithmetical average, *although the median may be used instead of the average.*"[9]

Rugg says, "For approximate work with educational data it is practicable to take the deviations from either the arithmetic mean *or the median.*"[10] Gregory, in his new manual, says: "The standard deviation is the square root of the mean of the squares of all deviations when the deviations are measured from a measure of central tendency, either the mean or the median."[11]

Even Kelley in his recent book, which is designed to follow the methods and notation of Karl Pearson and the English school, provides for an alternative meaning. He says, "The standard deviation . . . . is based upon the squares of the deviations from the mean. . . . *Unless otherwise stipulated* deviations are always from the mean."[12] For this he used the Pearsonian notation σ,

[7] Buckingham, B. R. "Statistical Terms and Methods," in the *Seventeenth Yearbook of the National Society for the Study of Education.* Bloomington, Illinois, Public School Publishing Company, 1918. Part II. p. 126 and p. 121.

[8] McCall, W. A. *How to Measure in Education.* New York, Macmillan Company, 1922. p. 383. There is a similar statement on p. 386.

[9] Wilson, G. M. and Hoke, K. J. *How to Measure.* New York, Macmillan Company, 1922. p. 262.

[10] Rugg, H. O. *Statistical Methods Applied to Education.* Boston, Houghton Mifflin Company, 1917. p. 169.

[11] Gregory, C. A. *Fundamentals of Educational Measurement with the Elements of Statistical Methods.* New York, D. Appleton and Company, 1922. p. 306. It is rather remarkable, however, that Gregory is not consistent, for within less than a dozen pages he says, "We defined standard deviation (p. 306) as the square root of the arithmetical mean of the squares of all the deviations measured *from the arithmetical mean* of the distribution." (p. 313)

[12] Kelley, T. L. *Statistical Method.* New York, Macmillan Company, 1923. p. 77.

but in his "List of Important Symbols," he says, "*s* designates the *standard deviation* from some point *other than the mean.*"[13]

Monroe is the only recent educational authority noted who states unequivocally that the standard deviation is used only with reference to the average.[14]

Biologists, Pure Mathematicians, Economists

So much for examples of variable definitions of the standard deviation in the educational field. What is the case for uniformity of definition in other statistical fields?

The origin of the term "standard deviation" is due to that master mind of modern statistics, the mathematical biologist, Karl Pearson, who first made use of it in a paper read November 16, 1893, before the Royal Society and published in their *Philosophical Transactions* in 1894.[15] He says, "Let the equation of the probability curve be

$$y = \frac{c}{\sigma\sqrt{2\pi}} e^{-\frac{x^2}{2\sigma^2}}$$

then σ will be termed its *standard deviation.*"[16] In this discussion the y-axis is taken "through the centroid of the frequency curve," which is equivalent to saying that it is computed from the arithmetical average or the mean. Elsewhere, with reference to the standard deviation, he says:

> The following is the rule to obtain it. Multiply the frequency with which each individual type occurs, by the square of its deviation from the mean; add all of the products together, and divide by the total number of individuals. This is the square of the standard deviation.[17]

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[13] Kelley, *ibid.*, p. 349.

[14] Monroe, W. S. *Introduction to the Theory of Educational Measurements.* Boston, Houghton Mifflin Company, 1923. p. 325. See supplementary note on page 52 of this article.

[15] Rugg is evidently in error when he states that it "was introduced by Karl Pearson *in 1896.*" *Op. cit.*, p. 168.

[16] Pearson, Karl. "Contributions to the Mathematical Theory of Evolution. (1. On the Dissection of Asymmetrical Frequency Curves)", in *Philosophical Transactions of the Royal Society*, Series A. Vol. clxxxv, 1894. p. 71. See also Yule, *op. cit.*, p. 80.

[17] Pearson, K. *The Grammar of Science.* (2d edition). London, Macmillan Company, 1900. p. 387.

And it is in this sense that it has been used constantly by Pearson and others in numerous articles published in *Biometrika*.

Davenport, the American statistical biologist, says:

> The index of the variability, σ, of the variates, when they group themselves about one mode, is found by adding the products of the squared *deviation-from-the-mean*. . . . This measure is known as the standard deviation.[18]

In the field of pure mathematics, Yule has already been quoted. West says, "the square root of the mean squared deviations *about the arithmetical mean* is called the standard deviation."[19]

Statistical authorities in the economic field are equally united in their definition and use. Thus Fisher in his recent treatise on index numbers, in speaking of averages to use in measuring dispersion, says:

> That usually employed is the "standard deviation," obtained by taking the average of the squares of the deviations of the individual price relatives (each deviation being measured *from the arithmetical average*), and extracting the square root.[20]

Bowley, in his standard treatise, says:

> The average of the squares of the deviations *from the arithmetical average* of the group is taken, and the square root of the average obtained is called the standard deviation of the group; this measurement of dispersion is in general use and is denoted by the letter σ . . . . The *standard deviation is always measured in relation to the arithmetical average, not to the median.*[21]

King says:

> The only measure of dispersion in this group (based on the second moment) in extensive use at present is the standard deviation. It is conceivable that a similar measure *might* be used whose deviations were based *upon the mode or median*, but the standard deviation is *invariably computed from the arithmetic average.*[22]

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[18] Davenport, C. B. *Statistical Methods.* New York, John Wiley and Sons, 1914. p. 15.

[19] West, C. J. *Introduction to Mathematical Statistics.* Columbus, Ohio, R. G. Adams and Company, 1918. p. 51.

[20] Fisher, Irving. *The Making of Index Numbers.* Boston, Houghton Mifflin Company, 1922. p. 390.

[21] Bowley, A. L. *Elements of Statistics.* (4th edition) London, Charles Scribners' Sons, 1920. p. 112.

[22] King, W. I. *The Elements of Statistical Method.* New York, Macmillan Company, 1913. p. 147.

Secrist says "the standard deviation is a modification of the average deviation. It is computed by measuring the respective deviations *from the arithmetic average.*"[23]

And finally Zizek says, "The mean square . . . . as a measure of the dispersion *about the arithmetical mean* . . . . is called the standard deviation."[24]

Theoretical and Practical

The weight of authority seems to be in favor of the standard deviation in terms of the mean, as given by Yule. What are the theoretical and practical considerations that favor it?

1. *The sum of the squares of the deviations from the mean is less than the sum of the squares of the deviations from any other value.* This is a most important property, both theoretically and practically. There is a theoretical advantage in always having the least possible sum of squares from which to work. It is the basis of all refined adjustments by the method of least squares. Yule, West, and others prove the exact relationship between the standard deviation—defined in terms of the mean—any and other mean square deviation.[25] This relation is so simple and illuminating that it is worth repeating here. If σ is the standard deviation, measured from the mean, s is the mean-square deviation from any other value, and d is the difference between the mean and the other value used, then

$$s^2 = \sigma^2 + d^2$$

This is perhaps most easily visualized in terms of a right triangle, in which s is the hypotenuse, and σ and d the two legs. This exhibits geometrically the fact that σ is always less than any possible s computed from a median, mode, or any other value which does not coincide with the mean.

It is because of this property that both Zizek and Rugg argue for the use of the mean square from the mean, namely the standard deviation, and on an analogous basis they argue for the use

[23] Secrist, H. *An Introduction to Statistical Methods.* New York, Macmillan Company, 1921. p. 400.

[24] Zizek, F. *Statistical Averages* (Persons translation). New York, Henry Holt and Company, 1913. p. 265.

[25] Yule, *op. cit.*, p. 134-35. West, *op. cit.*, p. 51.

of the mean deviation for measures based upon the median, because of the analogous property that the sum of the deviations from the median, in absolute value, is a minimum.

2. Another important advantage is that the standard deviation σ, computed from the mean, is the quantity that is needed for both the subject distribution and the relative distribution in the computation of the Pearsonian coefficient of correlation r, which is constantly used in educational statistics. It is also used in the computation of the probable error, the most common measure of reliability.

3. From the practical standpoint it is usually inconvenient to compute the standard deviation directly from the mean, because the mean is rarely an integral value, and the consequent labor of squaring a series of decimal differences is too great. However, the commonly used short-cut method of computing all the differences from an assumed integral value and making a correction at the end of the process, obviates this objection. This method is absolutely rigorous if the deviations are measured from the mean and is based directly upon the property given above. In fact the method is none else than the use of the right-triangle formula solved for σ,

$$\sigma^2 = s^2 - d^2$$

This short-cut method, however, is *not* correct in spite of popular supposition[26] to the contrary, and, therefore, cannot be employed for computing a mean-square deviation from any other average, such as the median. This constitutes the greatest practical advantage, from the standpoint of computation, of defining the standard deviation in terms of the mean.

In the *Grammar of Science*, the greatest statistical authority, Karl Pearson says:

> Other measures of deviation have been devised, some of which are occasionally useful, but for theoretical and practical reasons, the standard deviation may be considered the best. It is not hard to find, and it occurs and recurs in all sorts of investigations.[27]

[26] McCall, *op. cit.*, p. 386.
[27] Pearson, Karl, *op. cit.*, p. 387.

Conclusions

Of course, there can be no objection to any one computing *a mean-square deviation* from the median, mode, or any other value, if he wishes to do so. The only contention of this paper is that such a measure of variability should not be called the standard deviation. Summarizing the case for the definition of *the standard deviation exclusively in terms of the arithmetical mean, it may be said that:*

1. It is highly desirable that the *standard deviation* should mean the same thing to all statisticians, that it should be "standardized."
2. It was thus first defined and has been used ever since by the originator of the term, Karl Pearson.
3. The principal statistical authorities in all fields except those of psychology and education agree on it.
4. Educational authorities differ among themselves as to its definition, some defining it with reference to the mean only; some with reference to the median or mean; some with reference to the median, mean, or mode; and some with reference to *any* measure of central tendency.
5. It has certain theoretical advantages due to its minimal property.
6. It is desirable on account of its connection with the common measures of correlation and probable error.
7. It has decided practical advantages from the standpoint of computation.

Supplementary Note.—Since this paper was written and accepted for publication, a half dozen new books on statistical methods have been published. All of these agree in restricting the definition of the standard deviation to that advocated above. Two of these are in the field of education, Thurstone's *Fundamentals of Statistics* (New York, Macmillan Company, 1925. p. 100), Otis' *Statistical Method in Educational Measurement* (Yonkers-on-Hudson, World Book Company, 1925. p. 92); three are in the field of economics, Jerome's *Statistical Method* (New York, Harper and Brothers, 1924. p. 156), Mills' *Statistical Methods* (New York, Henry Holt and Company, 1925. p. 154), and Day's *Statistical Analysis* (p. 168); and most important of all, the National Research Council's *Handbook of Mathematical Statistics* (Boston, Houghton Mifflin Company, 1924. pp. 5, 28), prepared by nine statisticians, pre-eminent in their respective fields, throws the weight of its authority in favor of the original definition of the standard deviation in terms of the mean.

W. C. E.

Editorials

THE LAW OF SUPPLY AND DEMAND

It may not be altogether palatable to teachers to be told that their affairs—their salaries, tenure, and, indeed, the very existence of their positions—depend upon the same economic law which is said to regulate the price of wheat, the value of a dollar, and the wages of the laborer. Nevertheless this law does operate with respect to teachers; it is the law of supply and demand. If more teachers are available for a given line of work than there are positions in that line of work, salaries go down, hours of teaching go up, and working conditions are made exacting.

Moreover, under these circumstances persons who have been trained to teach but who find no opportunity to do so must of necessity take up other lines of work. Very likely they go out of teaching permanently. The money and time spent on their training then becomes, in large part, a loss to them as well as to the state. Or, what is more disturbing, they may take teaching positions for which they are not well qualified. This often happens when a position is available near the teacher's home. A teacher trained in home economics may be employed to teach a primary grade in her home town or French in the local high school.

On the other hand, if the demand for teachers of a given type greatly exceeds the supply, there is a tendency for salaries to increase and for working conditions to be easy. If this were all, the result would not be necessarily alarming. In the effort, however, to resist the rising cost of education, a community faced with an over-demand for teaching talent frequently employs, under emergency provisions, teachers possessed of less than the legal qualifications. Thus the service is debauched and

the children—in all these matters the "ultimate consumers"—are the losers.

Conditions in the schools will be most favorable when the supply of trained teachers is approximately equal to the demand. There are a great many ways in which this may be shown beside those mentioned above. If there is not a reasonable parity between supply and demand, the whole machinery for training teachers will be injuriously affected; the methods of selecting, assigning, transferring, and eliminating teachers will be weakened.

During a shortage of teachers the training schools will operate as a costly enterprise because their classes may be but half full. During an over-supply these institutions will likewise operate at high cost for they will be training teachers for a service which the state does not need.

In the placement and supervision of teachers, it needs no words to show that either over-supply or under-supply is a disadvantage. If the market is glutted with teachers, those under contract are in fear of losing their positions. They are sometimes compelled to sacrifice their independence of spirit, to toady, and to suppress their initiative. Supervision tends to become autocratic. If the teacher does not like the conditions let her resign; there are plenty more who would like her place. It is an employer's market. On the other hand, if there is an undersupply of teaching talent, teachers in service tend to become arrogant. They join federations and loudly denounce supervision as an infringement of their personal rights. They refuse to take on extra duties or do so reluctantly. The school system thus affected is in a sad condition.

If these facts flow from an excess of either the supply or the demand for teachers, then we may say that the matter of supply and demand is one which cannot lightly be disregarded. No formula of a special or partial nature will serve to suggest administrative action over an area so broad and in a service so complex as that of the state in the exercise of its educational function. It is of profound importance as a matter of public policy that the standard of reference be of a broad and inclusive nature. We

believe that there is no regulatory principle which more fully meets this condition or which may be more effectively invoked by the state than the relation of the provision for trained teachers to the need for trained teachers.

But what can be done about it? The first step is undoubtedly to secure an exact knowledge of conditions. What, for example, is the supply of trained teachers? No single answer is sufficient. Perhaps we think of the graduates of our training schools as constituting the supply. They are no more than potential supply. The real supply is only those who become teachers in the public schools. Our effective supply of coal is not the amount in the earth but the amount mined and delivered to the consumer. In respect to graduates of teacher-training institutions we must know how many of the gross number become teachers and how many become teachers in the state in question—for the state is the educational unit in this particular. We must also know how many of these graduates who become teachers in the state enter the type of service for which they were trained. We have altogether too many kindergartners teaching in the grades, home-economics teachers teaching history, and graduates of county normal schools teaching in city high schools.

On the other hand, and still with reference to "exact knowledge," we must know how many teachers are needed by the public schools of the state not only in the gross but in every significant particular, how much and what kind of training the teachers in each type of service should have, and, perhaps, the salaries which will ensure the desirable kinds of teaching skill.

Much more should be known—the number of students to be enrolled in training for each type of work in order to produce a sufficient number of graduates who in turn will yield a sufficient number of teachers, the geographical distribution of training schools necessary to recruit a sufficient number of students, the traits a student should have who intends to teach, and the best tests of such traits.

But it is not enough to have exact knowledge. Standards must be set up in the light of this knowledge. Normative measures will serve to routinize certain procedures and release energy, especially on the part of executives, for further constructive efforts.

Incentives must likewise be set up. If there is a shortage of teachers—and if one puts the standard high enough there is always a shortage—the way to meet the shortage is not merely to increase the supply but also to decrease the demand. The erection of incentives does both. If better salaries, better tenure, and more adequate pensions are secured not only will more persons become teachers, thus increasing the supply, but teachers will also remain in service longer, thus decreasing the demand.

Nothing less than a continuous study of teacher training in each state can be expected to produce satisfactory results. Nothing less than up-to-date exact knowledge will end the rule-of-thumb methods now in vogue. This is the task of a permanent office in the state department. This office should not only study supply and demand, but it should take an active part in bringing about a parity between supply and demand. The opportunity for placement work should be seized. Round pegs should be put into round holes and square pegs into square holes. The state office would have the best chance to know where teachers of every sort were needed. Why should the teacher who majored in Spanish be appointed to teach history when a position in Spanish is open—only to be filled by a person who majored in economics?

It seems to us that the law of supply and demand is so meaningful, so potent, and so suggestive in respect to teacher training that it ought to receive far more attention than it has received. We believe that if the problem of training, placing, and holding a sufficient corps of teachers is approached with this law in mind many of the needs of the hour may be met.

B. R. B.

Reviews and Abstracts

OTIS, ARTHUR S. *Statistical Method in Educational Measurement.* Yonkers-on-Hudson, New York, World Book Company, 1925. 337 pp.

The avowed purpose of this book is "to present the subject in such a way that it can be understood by those who know nothing whatever about statistical method" and "to cover all the topics that a school teacher, administrator, or researcher is likely to have need for."

The two most noteworthy features of this text, in the opinion of the reviewer, are the attempt to give insight into the meaning of the statistical calculations and the presentation of the correlated measurement problems necessary to form a background for quantitative interpretations. The first of these aims is attempted through the medium of logical rather than mathematical insight. The second feature is realized through the introduction of chapters on such topics as norms, growth of mental ability, reliability, correlation and prognosis, and grading and classification.

Genuine insight into statistical method may be little more than a "pious wish" on the part of the teacher of this subject to students of education, who, for the most part, have little or no mathematical background. Certainly, a purely mathematical approach is doomed to failure. On the other hand, it may not be necessary to go to the other extreme and teach a purely rote set of rules of computation. Many present-day textbooks in statistics present the subject much after the fashion of a physics or chemistry manual of a decade or two ago, namely, a sort of "Now take out flask A, next insert thistle tube B, then connect thistle tube B with rubber tube C" procedure. Dr. Otis has at least made the effort of avoiding the two extremes in teaching method. How far he has succeeded can only be judged after the critic has actually taught the text. The attempt is most commendable.

Throughout the entire text, Dr. Otis keeps his discussions "tied" to practical everyday problems of mental and educational testing, and in this way he draws upon a background of real or easily imagined experiences. The advantages of this device for teaching purposes are too evident for comment here.

Certain topics ordinarily omitted from the beginner's textbook in statistics appear, for example, partial and multiple correlation, the effects of unreliability on correlation, the significance of differences, and the uses of the Spearman-Brown formula. These inclusions are valuable since, with the possible exception of the first-mentioned topic, the calculations and underlying ideas are quite simple and probably fifty to ninety percent of educational investigations do, or should, use one or more of these procedures.

The book is not without its faults, and it occasionally fails to hold steadfast to its avowed purposes. Nevertheless, Dr. Otis has sensed the direction which a first treatment must take in a way that most books on statistical methods fail to do. It is certain of a warm reception at the hands of students of education.

G. M. RUCH

State University of Iowa

THURSTONE, L. L. *The Fundamentals of Statistics.* New York, Macmillan Company, 1925. 237 pp.

Dr. Thurstone has written a book which will be received by educators and psychologists as an important contribution. His years of experience in teaching statistics to graduate students who have entered psychology "from undergraduate majors in economics, literature, languages, psychology, and other unmathematical subjects" (p. v) have enabled him to write so as to be understood. School men and women who are looking for a book which will give them the more fundamental statistical methods in simple, non-mathematical language will find here what they desire.

The book, in its twenty-five chapters, discusses the tabulation and graphing of data, linear and non-linear relations, the measurement of central tendency and variability, the probability curve, and correlation. The explanations are concise but clear, intelligible but mathematically sound. The chapters are followed by problems affording the student an opportunity to practice the technique presented.

In the reviewer's opinion, the book has but two shortcomings worth mentioning. Neither the chapters nor the Appendix contains references for the student who may wish a more advanced discussion of the topics presented, and there is no consideration of partial and multiple correlation. The technique of partial and multiple correlation is so essential to the adequate treatment of problems involving a study of relationships that it should be included in an elementary text. It is not particularly difficult and would not be considered "highbrow" if more widely known.

The book merits a wide acquaintance among persons interested in psychological and educational research.

R. L. MORTON

Ohio University

HOLZINGER, KARL J. *Statistical Tables for Students in Education and Psychology.* Chicago, University of Chicago Press, 1925. 74 pp.

This book is intended to be *used.* Not only are the things in it useful, but the format itself is useful and good looking, as well. It is a thin, wide, flat volume, admirably adapted for desk use and will conveniently fit into one's brief-case.

Most workers in educational statistics will deal with populations small enough for the application of these tables of squares and square roots, products, and quotients. The four-place logarithms will suffice for ordinary work. In education and psychology the limits of reliability are such that the extreme refinement of such operations often gives mere pedantry.

The logarithms of $(1 - r)^2$ and of $\sqrt{(1 - r)^2}$ have important uses in the calculation of partial and multiple correlation coefficients. The values of $\sqrt{1 - r}$ will be found useful in computing constants of the form $\sigma\sqrt{1 - r}$.

In calculating the probable error of a mean one needs to multiply the standard deviation by $0.6744898/\sqrt{N}$. Accordingly, the author gives a table of values of this fraction for N's up to 1,000. Another table gives the probable errors of correlation coefficients from zero to .98 for values of N from 20 to 1,000.

Finally, two tables are given concerning the normal surface of frequency. The first expresses the relation between deviation and length of ordinate; the second, the area between the maximum ordinate and the ordinate at the deviation. The first of these tables is useful in curve fitting. The second is especially valuable in scaling test data.

We believe that this set of tables is sensibly selected. Students of statistics and workers in the field will have real use for it.

B. R. BUCKINGHAM

Ohio State University

SCOTT, CHARLES EDGAR. *Educational Supervision.* Milwaukee, Bruce Publishing Company, 1924. 98 pp.

The author states in his Preface that the volume is intended "for principals, supervisors, and superintendents and for use in classes in supervision in teacher-training institutions." He points out that supervision has evolved from school management and is distinguished from school administration in that the latter has to do with material means and conditions of instruction, while the former is concerned with the coordination, stimulation, and direction of instruction. He lays down certain guiding principles and states and illustrates certain aims. He has garnered copiously from other writers in the field of supervision and woven together these citations, his experience, and his philosophy into a very readable monograph.

Those who are preparing for supervisory work will profit by a careful study of this little volume. Many teachers would undoubtedly get a clearer conception of what supervision is and what the supervisor is endeavoring to do by reading it. It seems to be well fitted for the group it was intended to serve. On the whole it is a simple statement of a sane view of the subject. While it leaves much to be said, little that is said will be challenged by thoughtful students of the subject.

E. J. ASHBAUGH

Ohio State University

RUSSELL, W. F., HOLY, T. C., STONE, R. W., and others of the Iowa Staff. *The Financing of Education in Iowa.* New York, Macmillan Company, 1925. 279 pp. (Volume VIII, Publications of the Educational Finance Inquiry)

The purpose of the study is the analysis of the financing of public education in Iowa for the period 1910 to 1922. Part I is an intensive study of present school expenditures, entitled "What Does Iowa Expend for Education?" Part II, entitled "What Can Iowa Afford to Spend for Education?" seeks to establish the fact, that with certain suggested reforms, the state without undue financial effort can provide for the further necessary extensions in education indicated in the report.

The complexities of the classification of school expenditures used in the *Iowa School Law* necessitated the use of a definite terminology, which was carefully set up in the Introduction and consistently followed throughout the study. The inadequacy of present forms or blanks for reporting school data, and the incomplete and non-uniform systems of financial accounting used in the various districts multiplied and magnified the difficulties encountered by the investigators. The handicap due to discrepancies in accounting was largely overcome by the frequent use of questionnaires and the examination of many original records. The hearty cooperation of the State Department of Public Instruction, as well as county and city superintendents was also of inestimable value in the collection of reliable data. This in itself constitutes one of the highest values of a comprehensive financial study of this kind, since it creates much interest among those most vitally concerned.

In keeping with the thoroughness of the survey, a careful analysis was made of the school bonded indebtedness in the various school districts, and of the general system of taxation of the state. Appendices A to E contain the methods used in the study and present rather complete data concerning the cost of public education in Iowa. These in themselves are splendid contributions to the field of school finance.

There is some opportunity for criticism as to the methods and technique employed. The method of treatment was perhaps made necessary by difficulties inherent in the present methods of recording data by local and state school officials. Faults in style and lack of clearness in the construction of certain sentences might be designated. While there are some evidences of inaccuracy and incompleteness, the general excellence of this investigation is so marked, and its scope so comprehensive, that it deserves full recognition as a major contribution to the literature of school finance.

The data included in this study are of worth not only to school administrators in Iowa, but also to students of school finance throughout the United States, particularly in other agricultural states of the Middle West.

Praise and congratulation are due Professor Russell and his associates for the eighth volume of The Finance Inquiry Series.

JOHN GUY FOWLKES

University of Wisconsin

WALLIN, J. E. W. *The Education of Handicapped Children.* Boston, Houghton Mifflin Company, 1924. 394 pp.

The mature convictions of Dr. Wallin regarding the diagnosis, training, and social care of handicapped children have here been assembled with their historical background. Every teacher of a special class should find this book very profitable, if not essential. After fifteen years devoted to making clinical diagnoses, organizing and supervising special classes in the public schools, and training teachers for such classes in connection with a number of universities, the author speaks from an experience and understanding of the problems which make his book the most authoritative summary of the present status of this work.

The three parts of the text are headed: (1) "The History of the Education of Handicapped Children, and the Psychological Theories and Definitions of Feeble-mindedness and Backwardness," (2) "Public-School Questions Relating to the Education of Handicapped Children," (3) "The Social Menace of the Feeble-minded, and the Program of Constructive Endeavor in Their Behalf." All have excellent, selected bibliographies. The author has made a notable contribution in clarifying the terminology and classification of forms of defective, subnormal, and super-normal children. His distinctions are sound and better analyzed than other more limited treatments of this field. He re-states his well-known conservative position regarding the borderline of tested feeble-mindedness. It was boldly announced in independent agreement with one or two others over ten years ago and has now come to be generally accepted by clinical psychologists.

The main service of the book is its systematic statement of the present status of the science and education of handicapped children of all types. This includes principles, plans, and methods for the guidance of teachers and supervisors of special classes.

On the problem of the social control of deficiency he takes the admirable position that the feeble-minded will be incapable as parents even if they should occasionally have a passable child. Their inefficiency as parents is sufficient justification for social control. Any teacher would gain inspiration from experience with the children of special classes and such a course as this text contemplates. Dr. Wallin has in preparation a companion text on clinical psychology and psychopathology summarizing the experimental work under a more intensive treatment. The present book meets, however, the wider need.

J. B. MINER

University of Kentucky

TEAGARDEN, FLORENCE M. *A Study of the Upper Limits of the Development of Intelligence.* New York, Teachers College, Columbia University, 1924. 112 pp. (Teachers College, Columbia University, Contributions to Education, No. 156).

The rather ambitious task which Dr. Teagarden describes in this monograph consists in an attempt to find, on the basis of four tests applied to 408 children: (1) "the point at which the intelligence stops developing quanti-

tatively, as a whole, and as to its constituents''; (2) ''the shape of the curve of mental growth''; and (3) ''the amount of variability with succeeding age-groups.'' Her subjects, who were orphans between the ages of twelve and one-half and twenty, included all of the children of both sexes between these ages in the institution maintained by the Order of Moose for children of deceased members of that lodge. The tests, Army Alpha, Stenquist Mechanical Aptitudes, Pressey Senior Classification, and Stanford Binet, were chosen with a view to their reliability as ''measures of innate intelligence'' and their virtue as tests of the mechanical and abstract ''varieties of intelligence.'' The inference that a study of successive age-groups represents in cross-section the normal growth of intelligence is based, as the author points out, on the assumption that the groups are not otherwise selected and that there are sufficient numbers of cases at each age level.

The results of the study seem to substantiate the view that intelligence continues to develop beyond the age of sixteen years. There is some evidence that the form of the growth curve indicating fairly even negative acceleration is probably correct for ages between twelve and eighteen. The findings with respect to variability are somewhat equivocal. They appear to reverse the usual differences between group and individual tests indicating an increase in variability with age when group measures are used and a decrease in variability with the individual test. As the author points out, this actual decrease in variability with increasing age is undoubtedly due to the well-known fact that subjects as old chronologically as were those of the present study are inadequately tested by the Stanford Binet Scale. This ''end-error'' as Dr. Tergarden calls it, prevents the usual scattering of successes beyond the basal age. The indication is, therefore, that variability as measured by both group and individual tests increases with age. Such slight evidence for the limits of growth of the ''constituents'' of intelligence as is afforded by an inventory of the tests that make up the battery of Alpha and Pressey can hardly be given serious consideration as contributing to an analysis of ''what the tests test.''

The author's assumptions with regard to the unbiased nature of her sampling in a group of dependent children, even under the conditions governing admission to the particular institutional group chosen, are at least open to question. Her interpretation of what constitutes ''sufficient numbers'' of cases to justify her procedure and conclusions might also be questioned, especially in view of the possibility of sex differences in the age of maturing of intelligence which makes desirable a consideration of the results for boys and girls separately. The study should stimulate further research in the same field.

MAUD A. MERRILL

Stanford University

BISCH, LOUIS E. *Clinical Psychology*. Baltimore, Maryland, Williams and Wilkins Company, 1925. 346 pp.

The importance of clinical psychology as a vital means of aiding in the solution of some of the most difficult problems of school administration and

classroom management has been largely overshadowed by mere intelligence testing. The comparative dearth of clinical psychologists and the professional intricacies of the subject are practical difficulties that retard developments in this significant field. And yet some of the most baffling problems in educational adjustment are easily solved with the aid of even a little knowledge of abnormal psychology and clinical technique.

The present volume will help to meet these needs and should encourage a wider application of clinical psychology in the public schools. It comprises reliable descriptions of more clinical types of defective children than are usually found in a single volume. It also brings together important data liberally quoted from authoritative sources that will be of material assistance to students and teachers. The author borrows freely from other authorities, thereby collating comparatively isolated material bearing on the subject of mental diagnosis and defective children.

"The primary object of this book is to give the teacher a working basis by means of which he or she may be able to recognize an atypical child in the classroom and to know best how to handle the situation." To accomplish the first of these objects there are chapters on the normal child; the precocious child; the retarded child; psychopathic, epileptic, and feeble-minded children; functional disturbances in childhood (nervousness, psycho-neuroses, neurotic manifestations, and syphilis). Some of these chapters are excellent; others are inadequate, and some are superficial. The second object is lost sight of or left to implication, for the significance of these types from the standpoints of classification, differential pedagogy, specialized curricula, disciplinary methods, and the like is ignored.

The work is not so much a treatise on the methods of clinical psychological diagnosis as on certain types of abnormal children. The point of view presented is essentially medical rather than psychological, and the author states that "the person who evaluates all the available data—assembled by six different specialists—should be a medical expert trained in this type of work," and that the "summing-up of the facts of the case should, of course, be made by the neuropsychiatrist in charge of all the procedures." The subject-matter is relatively low on psychology, and the psychology employed is traditional rather than modern.

The volume is in seventeen chapters. The best we consider: "Methods of Examination" which is good on case-history taking, but poor on psychological tests and methods; "The Normal Child," all too often overlooked by clinicians; "Mental Retardation," dealing with remediable subnormalities; "Epilepsy," an exceptional condensation of this difficult and important topic; "Syphilis," a sane and clear discussion for the layman; and "Mental Testing," a compendium with historical notes.

There is an appendix of more than one hundred pages presenting illustrative cases. These are not very illuminating, however, for they are histories rather than diagnoses. It is here that we specially note, the absence of quantitative examinational data (only Binet data being given), and we regret that the author does not rationalize his diagnoses. There are numerous illustrations, but they lose much of their value for lack of descriptive notes and are

not correlated with the textual matter. There is a bibliography, also uncorrelated with the text. In the text itself references to the work of leading clinical psychologists are conspicuously absent.

EDGAR A. DOLL.

Ohio State University

BRINKLEY, STERLING G. *Values of New Type Examinations in the High School, with Special Reference to History.* New York, Teachers College, Columbia University, 1924. 121 pp. (Teachers College, Columbia University, Contributions to Education, No. 161)

Dr. Brinkley experimented with true-false tests, with and without negatives; with multiple-choice tests, including three, four, and five choice groups; with both short and long completion tests; word or phrase answer tests; and arrangement tests. All were compared with "old-type essay tests."

The results of the investigation are summed up by Dr. Brinkley in a short paragraph worth quoting:

Given tests of equal length, as measured by time spent in testing, and prepared by teachers with some training in the matter of test construction, one type of test yielded practically as good results as another for measuring achievement in history in the senior high school. With one or two exceptions, this was true whether the achievement measured was general achievement for the course, ability to think with the materials of the course, or information.

This summary describes not only the results of the experiment, but also points out the limitations which Dr. Brinkley set for his work, the comparison of the more immediate values of the tests themselves. The title of this monograph does not indicate that this limitation had been set, and the results, therefore, might superficially be taken to indicate that there was relatively little difference in total value between traditional essay forms of testing and the newer forms. As a matter of fact the importance of the newer forms seems likely to lie in the remoter values of testing, in the changes in the study habits of pupils, in the greater insight which a teacher can bring to his work, in the greater opportunity for handling results in a scientific manner, and in the greater significance of the results so found. Whether or not these things be true, Dr. Brinkley has cleared the air in such controversy as there has been with respect to the relative, immediate values of these tests, provided only that one can accept the "old-type" essay test which he used as representative of the essay type in traditional use for examination purposes.

The traditional form of essay examination has been one in which the subjective judgment of the teacher has played a large part in the interpretation of the answers which have been written. This is fundamentally a different philosophy from that underlying the new type tests. The essay tests, however, which were used by Dr. Brinkley were so treated as to eliminate as far as possible this subjective judgment.

The philosophical basis upon which the essay tests were treated was fundamentally the same as that of the other tests, and these tests were, in fact, new-type, rather than traditional, essay forms. For this reason the comparisons which are drawn, while carefully executed and accurately treated, lose much of

their force. It is unlikely that there could be much difference in the two forms of the tests, no matter how they were called, if both forms had the same underlying philosophy.

In spite of these limitations this monograph is a distinct contribution. For those who desire information as to the comparative immediate values of informal tests such as are now being used in our schools Dr. Brinkley's interpretations are excellent; for those who are struggling with the technique of making, giving, and scoring these tests, the monograph is of especial value. It should be read by all teachers who are using these tests, whether they be teaching in elementary school, high school, or college.

CHARLES RUSSELL

West Normal School, Westfield, Massachusetts

SMITH, NILA B. *One Hundred Ways of Teaching Silent Reading.* Yonkers-on-Hudson, New York, World Book Company, 1925. 149 pp.

This book presents a variety of suggestions for classroom procedure in the teaching of silent reading. It is unrelated to any particular text or method. The first two chapters give a comprehensive résumé of the conditions affecting the changing emphasis in reading and general suggestions for the teaching of silent reading. The following chapters give exercises to increase certain factors involved in reading, such as speed, comprehension, selection, organization, and retention.

Many of the exercises are excellent and will prove to be a real help to the inexperienced teacher or the teacher who is not familiar with the teaching of silent reading. A large proportion of the exercises is miscellaneous so far as material and vocabulary are concerned, and for that reason is best adapted to use in study periods. On the whole, the exercises are most suitable for primary grades. Some of those recommended for intermediate grades are of doubtful value for pupils who have reached that stage of reading experience.

The game and device element is rather prominent in a number of the exercises. In some of these the activity—the searching, the dramatizing, and the score-keeping—takes precedence over the actual reading involved. Exception may be taken to the recommendation that pupils "find little words in big words." Among the illustrations given are *t-hat, w-hen, s-now*—instances in which this practice is phonetically misleading and defeats its purpose. Further illustrations give such divisions as *wind-ow, pill-ow, yell-ow,* all of which are misleading as to syllabication.

On the whole, the book will be helpful to many teachers who will get suggestions which they may be able to apply to the material they are using in their classes. We regret, however, that the exercises were not limited to those having greater results.

MYRTLE L. KAUFMANN

Elementary Supervisor, Logansport, Indiana

Publications Received. October 15 to November 15

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Micoleau, H. F. and McLellan, H. H. *First two years of French: a grammar.* New York, Sanborn, 1924. 564 pp. $1.76.

Miller, H. L. and Hargreaves, R. T. *The self-directed school.* New York, Scribner's, 1925. 412 pp. $1.80.

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Morrison, F. W. *Equalization of the financial burden of education among counties in North Carolina.* New York, Teachers College, Columbia University, 1925. 88 pp. (Contributions to education, No. 184). Cloth, $1.50. Paper, $1.25.

Myers, G. C. *Diagnostic test; verb demons.* Cleveland, Ohio, Harter School Supply Co., 1925. Per pad, $.20.

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National League of Teachers' Associations. *Introduction to the problems of teachers' associations.* Minneapolis, Minn., The Author, 1925. 96 pp.

Number flash cards. Cleveland, Ohio, Harter School Supply Co., 1925. Per set, $.25.

Parker, S. C. and Temple, Alice. *Unified kindergarten and first-grade teaching.* Boston, Ginn, 1925. 600 pp. $2.20.

Perry, F. M. *Progressive composition.* Yonkers-on-Hudson, N. Y., World Bk. Co., 1925. 358 pp. $1.44.

Reigner, C. G. *Drills and reviews in Rowe shorthand.* Baltimore, Rowe, 1923. 75 pp. $.56.

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Sherman, J. J. *The county superintendent of schools in Iowa.* Iowa City, Ia., State Historical Society of Iowa, 1925. 32 pp.

Sherwood, H. N. *Our country's beginnings.* Indianapolis, Bobbs-Merrill, 1924. 337 pp. $1.50.

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Smith, E. S. comp. *A book of lullabies.* Boston, Lothrop, 1925. 562 pp. $2.50.

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Social guidance in Cleveland high schools. Cleveland, Ohio, Cleveland Teachers' Federation, 1925. 189 pp. Cloth, $1.25. Paper, $.50.

Spaeth, J. D. *Old English poetry; translations into alliterative verse with introductions and notes.* Princeton, N. J., Princeton University Press, 1924. 268 pp. $2.00.

Stephenson, S. C. *Picture studies required by courses of study for elementary schools.* Lincoln, Nebr., Lincoln School Supply Co., 1925. 159 pp. $2.50.

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Stone, J. C. and Hart, H. F. *Elementary algebra.* New York, Sanborn, 1925. 371 pp. $1.28.

Swift, F. H. and Goldthorpe, J. H. *Studies in public school finance; the South, Arkansas, Oklahoma, Alabama, Tennessee.* Minneapolis, Minn., University of Minnesota, 1925. 224 pp. (Education series, No. 4). $2.50.

Terpenning, W. A. *Social organizations working with rural people.* Kalamazoo, Mich., Western State Normal School, 1925. 125 pp.

Tyler, J. M. *The coming of man.* Boston, Marshall Jones, 1923. 147 pp. $2.00.

Weiss, A. P. *A theoretical basis of human behavior.* Columbus, Ohio, R. G. Adams, 1925. 428 pp. $2.50.

Worst, E. F. *Letters and pictures for alphabet book.* Chicago, Flanagan, 1925. Per envelope, $.35.

Worst, E. F. *Worst's matching number cards; for first grade.* Chicago, Flanagan, 1925. Per envelope, $.15.

Worst, E. F. *Worst's primary picture cut-outs.* Chicago, Flanagan, 1925. Per envelope, $.30.

Worst, E. F. *Worst's word building cards; for primary grades.* Chicago, Flanagan, 1925. Per envelope, $.20.

Young, E. J. *Practical grammar game; for grades five to eight.* Chicago, Flanagan, 1925. Per set, $.35.

Zaner method perception strips. Columbus, Ohio, Zaner-Bloser, n.d. Per dozen sets, $8.16.

News Items and Communications

This department will contain news items regarding research workers and their activities. It will also serve as a clearing house for more formal communications on similar topics, preferably of not more than five hundred words. These communications will be printed over the signatures of the authors. Address all correspondence concerning this department to Doctor E. J. Ashbaugh, Ohio State University, Columbus, Ohio.

A Division of Educational Reference has been established at Purdue University under the direction of F. Dean McClusky. The Division is designed to make a careful and systematic study of local administrative and educational problems.

Dr. Elizabeth Woods, formerly Director of Special Classes in Wisconsin, is the new Director of the Department of Psychology and Educational Research in Los Angeles. This is one of the largest research departments in the country, having twenty-four assistant supervisors, teacher assistants, and clerks in its central office.

Superintendent W. A. Walls, of Kent, Ohio, has sent us a copy of his senior high-school report to parents. The report is a four-page folder 8½"x 11", and, in addition to information in regard to the attendance and the marks of pupils, it provides for scores on standard tests, and a periodic checking on various habits related to good citizenship and health education.

We have been interested in the possibility of a more valuable pupils' report card for some time and will welcome from our readers copies of any cards which provide unusual information or mechanical makeup.

The National Thrift Committee, 347 Madison Avenue, New York City, is already distributing material for Thrift Week, January 17-23, 1926. The slogan is "For Success and Happiness." The movement is based on the following ten-point economic creed: work and earn, record expenditures, carry life insurance, own your home, share with others, make a budget, have a bank account, make a will, pay your bills promptly, and invest in safe securities. Interested teachers may secure free copies of a new calendar poster with official dates and topics from the Committee.

Dr. Prince Lucian Campbell, president of the University of Oregon since 1902, died on August 14. President Campbell was an educational pioneer of the northwest where he has exerted a tremendous influence. His father was

for a number of years President of Christian College at Monmouth, Oregon, and Dr. Campbell himself held the same office at the time it became a state normal school. In 1918 he assisted in organizing the Emergency Council on Education which has since become the American Council of Education.

The National Bureau of Economic Research has recently ascertained that 15 percent of the national income is received by the citizens of New York State, while the citizens of seven states, New York, Pennsylvania, Illinois, Ohio, Massachusetts, California, and Michigan, receive nearly 50 percent. On the other hand the seven states, Utah, Arizona, Vermont, Wyoming, New Mexico, Delaware, and Nevada receive scarcely 2 percent. When the income is figured on a per capita basis, however, the order is not the same. The data have been brought together in a recent report called *Income in the Various States*.

Dr. A. H. Sutherland, for seven years head of the Department of Psychology and Educational Research in Los Angeles, has recently opened an office and private corrective school in that city. He is prepared to make psychological and educational diagnoses based upon standard-test results and to provide corrective tutoring in school subjects. This scheme is designed especially to discover the status of any child's present educational development, to stimulate constructive imagination, to establish fundamental habits and motives, and to round out the development of the child in the shortest possible time. Mrs. M. W. Arleigh, formerly a teacher at the San Francisco State Normal School, will assist in this work.

The University of Minnesota announces that Volumes III and IV of "Studies in Public-School Finance," have been received from press and are ready for distribution. These investigations were prepared under the direction of Professor Fletcher Harper Swift, formerly of the College of Education of the University of Minnesota, and now of the School of Education of the University of California.

Volume III, *The Middle West*, contains studies of public-school finance in Illinois, Minnesota, and South Dakota, together with a supplement on public-school finance in Alaska. Volume IV, *The South*, contains similar studies of conditions in Alabama, Arkansas, Oklahoma, and Tennessee.

The four volumes of the present series cover no less than one-fourth of the states in the Union and constitute a notable contribution to the scientific literature in the field of public-school finance. Copies of these volumes may be secured from the Librarian, University of Minnesota.

Ten cities in which three-year demonstrations of visiting-teacher work have just been completed under the auspices of the Commonwealth Fund program for the Prevention of Delinquency have determined to continue the use of the visiting teachers as a regular feature of their public-school systems. The visiting-teacher movement originated in New York City, Boston, and Hartford, Connecticut, during the year 1906-07. It has apparently justified itself in places which have given it a fair trial. A great part of the work

of such teachers is concerned with maladjustments of scholarship and behavior which may not necessarily lead to delinquency but which frequently can be prevented if problems of behavior and personality are adequately dealt with early in the child's school life.

The introductory portion of the bulletin entitled *Latin Playlets for High Schools* (University of Iowa Extension Bulletin No. 131, September, 1925) gives reasons for the presentation of Latin plays in high school and some of the directions for their presentation. Twenty brief plays then follow: one for students in the first half-year, eight for those in the second half-year, eight for the third half-year, and three for the fourth semester.

The Fourth Yearbook of the Department of Elementary-School Principals is entitled *the Elementary-School Principalship—A Study of Its Instructional and Administrative Aspects.* The bulletin is divided into three sections; instructional, administrative, and personnel. Twenty articles by various writers deal with different aspects of the instructional problem and comprise the first section; five articles, the second; and three, the third. The material varies in value as such a composite always does; but any elementary-school principal will certainly find a large amount of material of practical value in this volume of reports of practice throughout the country.

Where Pupils Fail in Verbal Problems

This study aims to replace guessing and theorizing about why pupils fail to do verbal problems by an analysis of the errors made in a large number of problem solutions by sixth-grade pupils. Similar studies have been made especially in the field of computation or examples, by Morton and others. It seemed to us that this method of attack on verbal problems, meaning of course what are sometimes called story problems, or written-out problems, should prove equally fruitful.

The first and foremost difficulty encountered in such a study is that of classifying errors. Probably no two persons would quite agree on any complete scheme. The writer arrived at his scheme by the trial-and-error method rather than by any a priori assumptions. In other words the scheme used was finally adopted, because it was found to work with at least a fair degree of success. It accounts rather definitely for most of the errors made in the papers analyzed. It would no doubt need to be extended and modified if the range of either pupils or of problems was increased.

The three main heads used are (1) ignorance of principle or rule, (2) computation, and (3) comprehension. These terms are used in a broad sense, as the subheads will indicate. They sometimes overlap. The classification of a particular error sometimes had to be guessed or inferred, but this could be done quite intelligently with the pupil's work before us. Of course some errors could not be classified and are thus tabulated. When two or more errors occurred in a problem, it was classified according to the error which seemed to be vital in causing the pupil to fail on the problem. If two errors were both apparently vital in their consequences, both were tabulated.

TABLE OF ERRORS IN VERBAL PROBLEMS FROM APPROXIMATELY ONE THOUSAND PROBLEM SOLUTIONS BY SIXTH-GRADE PUPILS

		No. of Errors
I.	Ignorance of Principle or Rule	
	1. Wrong operation performed	377
	2. No intelligent attempt made	8
	Total	385
II.	Computation	
	1. Purely mechanical errors	260
	2. Inability to handle fractions	21
	3. Inability to handle mixed numbers	57
	4. Errors in pointing off decimals	52
	5. Operations not carried far enough	37
	6. Failure to reduce answer to lowest terms	42
	Total	469
III.	Comprehension	
	1. Vocabulary difficulty	20
	2. Misinterpretation of meaning of problem	59
	Total	79
IV.	Errors in Use of Tables of Measure	44
V.	Answer Wrongly Labeled	28
VI.	Sheer Carelessness	20

By purely mechanical errors is meant such an error as 7×8 is 54. Inability to handle fractions means that the pupil seems unable to do the problem because he does not know how to add, subtract, multiply, or divide fractions, as the case may be. The same applies in mixed numbers. Under comprehension we tried to make a distinction between difficulty with technical terms, such as minuend, perimeter, and the like; and the apparent inability to correctly interpret the meaning of the problem. The other classifications seem to be self-explanatory.

One should remember that the problems analyzed were limited to the sixth grade and to about six months of the school term. Also, that they were selected from one text. It is entirely likely that a different selection or a wider range of either problems or pupils might change considerably the classification of errors. It is believed, however, that the above table should have some significance and should prove a good working basis for attempts to improve ability in solving verbal problems.

O. S. LUTES

State University of Iowa

Individual Needs and School Adjustments

For the past two years the Department of Research of the Oklahoma City schools has been stressing the need for the study of individual differences and the adjustment of the curriculum and the administration of the schools to meet the individual needs. Along with a rather thorough testing program a two-hour college course in mental testing, with emphasis on the use of the Binet test, has been given to 311 teachers of the system. Numerous conferences have been held with the principals as a group and with the principals and the teachers at the respective buildings.

Our chief aim has been to help the teacher to know the child and teach the child rather than to teach any particular subject-matter; to find where each

child is physically, socially, mentally, and educationally. If the child is where he should be, give him a full-balanced educational ration. If the child is not where he is getting the most out of his time spent in school, the aim has been to adjust the matter by giving the child a trial at the place in school where it seems his different ages would place him and then make a special effort to bring up his weak points and give him a well-balanced educational ration. Realizing the dangers of getting the child too far ahead of his chronological-, social-, and physical-age group, it has been the policy of the Department to discourage more than a minimum of acceleration of a child beyond his chronological-age group. In general, our plan of meeting the needs of the superior child has been that of enrichment rather than acceleration.

The following is a report of the adjustments that have been made during the first semester of the school year 1924-25. In the elementary schools of the city 186 children have received a special promotion of one half-year. Thirty-three of these children, as a result of this extra promotion, are now one-half year ahead of their chronological-age group, 12 are now one year ahead of their chronological-age group, and 2 are one and one-half years ahead of their chronological-age group. These 47 children, or 25 percent of the total, have received actual acceleration.

Adjustments.—The remaining 139 children who received an extra promotion had at some previous time, for some reason, failed to make their grade with their class and were as a result, one or more half-years behind the group with which they started school. In other words, these 139 cases were children who received a "school adjustment."

The final criterion for judging the justification of these adjustments and accelerations should, of course, be: Did these children make good in the grade to which they were promoted? According to the testimony of the teachers less than 5 percent of these children will fail to pass in the grade to which they had been promoted. Of those actually accelerated, at least 80 percent are now doing work equal to or better than the best one-third of their class.

Who was promoted?—The average intelligence quotient of the 47 children who were accelerated was 123. Only one child in this group had an intelligence quotient of less than 100. There were only two in this group whose mental ages were not equal to the normal age for the grade to which they were promoted. Their educational ages and in practically all cases their grade standings, B-scores, in the fundamental subjects, reading, arithmetic, and spelling, were above the average for that grade.

The mental age of the other 139 children who were given an educational adjustment was, in practically all cases, equal to, or in advance of, the normal age for the grade to which they were promoted. In many of these cases the chronological ages of these children were as much as two, three, or four years in advance of the normal age for the grade. The B-scores of practically all of these children in at least two of the three subjects mentioned above were equal to, or higher than, that for the grade to which they were promoted.

How information was obtained.—The information for this report was obtained by a blank form which was filled from data in the hands of teacher and

principal. It gave for each child, name, chronological age, normal age for grade, grade promoted to, normal age for this grade, intelligence quotient, mental age, normal grade of this mental age, and B-scores in reading, spelling and arithmetic. There was also space for remarks by teachers giving other causes for acceleration. The achievement records in the subjects indicated are kept up to date by the use of standard tests given at the beginning and end of each semester.

The big saving in time and money.—It costs practically $38 per semester for each child in the elementary schools of our city. The sum required for the instruction of these 186 children at $38 would have been $7,068, but this amount was actually saved. It would have taken *five* teachers one half-year to have given these children this extra semester of schooling which combined evidence showed they did not need. In fact, they might actually have been harmed by having to sit through this extra half-year because of the training in loafing that they would have received. On the 139 children who received an educational adjustment a total of $5,282 was saved. This saved four teachers for one semester. There is no doubt that any large amount of acceleration of young children beyond the group of the same social, physical, and chronological age has definite dangers; but for these 139 children there seems to be no possible reason why they should not be given this chance.

Probably the largest benefit of all was the saving of one half-year for each of these 186 children. The encouragement received by this new opportunity also meant much to each child. This report deals with only those children whose conditions demanded immediate special attention. How great was the value to the other twelve thousand or more children whose needs received just as thorough study as did those of these 186 can hardly be estimated. The total cost of this study of individual need has been comparatively small. Certainly this type of work is much needed and worth while.

L. D. Lacey

Director of Census and Research, Oklahoma City

The Computation of Simple Percents of Distributions

The casual reader will wonder why an article should be written on the computation of percents since apparently the computation of percents is such a simple matter, quite unlikely to be accompanied by errors, as only one process, that of division, is involved in determining a given percent.

It is not true, however, that even if correctly computed the total of the percents of a given distribution, which should add up to 100.00 percent actually do add up to 100.00 percent. We frequently find even published researches involving percents the sum of which when added do not yield 100.00 but instead give 99.5, 99.8, 100.1, or 100.2. The trouble quite evidently lies in the great difficulty of dropping decimals in such a way that the sum of those retained will add up to an even 100 percent. The plans outlined below obviate the difficulty involved in the computing and recording of more decimals than are ultimately desired with the subsequent troubles and errors

involved in dropping of percents. The procedure is so simple that almost any clerk can invariably secure the same results as a highly skilled statistician.

Case I. Paper and pencil being available.—The general principle of the method presented in this article is involved in this case, namely, (1) the summation of the frequencies into a cumulated frequency distribution; (2) the subsequent calculation of cumulative percents to the number of decimal places required in the finished simple percentage table; and (3) finally the subtraction of successive cumulative entries in order to determine the simple percents.

If the subtractions have been adequately done, the sum of these simple percents will be 100.00 even though some of the cumulative percents be in error. The only check upon the accuracy of the computations of the cumulative percents is consequently recomputation.[1] The only necessary check upon the accuracy of the subtractions, involved in finding the simple percents, is that the sum of these simple percents should be 100.00. The calculations, in the order in which they are performed, are shown successively in columns 2, 3, 4, and 5 of Table I.

Case II. A slide rule being available.—In this case the cumulative frequency column (*Column 3*) is found as in Case I. The slide rule is then set at the reciprocal of the number of cases, and the cumulative percents are read off directly and rapidly from the slide rule opposite the successive values of the cumulative frequency column. Set N on scale C opposite either index of scale D. On scale D find the respective cumulative percents opposite cumulative frequencies on scale C. This method is extremely rapid, but the individual cumulative percents may be in error due to the estimations involved in reading to three of four significant figures on the slide rule. Such errors are reasonably infrequent in the simple percents, but in spite of such error the simple percents will always add up to 100.00 which is a more essential requirement than that each simple percent should be absolutely exact in the very last decimal place which is retained.

Case III. A calculating machine being available.—In this case the cumulative frequency (*Column 3*) need not be determined. After obtaining the reciprocal of N which is entered into the keyboard of the calculating machine, one multiplies the reciprocal of N by the frequency of the lowest class and writes down the product opposite the frequency of the lowest class. Without disturbing the already cumulated product the reciprocal is multiplied by the frequency of the second class, this second product being allowed to accumulate upon the first product. The first two cumulative percents are thus quickly found, and so on throughout the series. The reciprocal of N should be checked by multiplying it by N and then setting up the proper decimal places before beginning these multiplications. N times the reciprocal may be made to equal exactly 100 percent to as many as eight or nine decimal places by taking a reciprocal computed to nine or ten decimals. Such

[1]Another readily applied check is: Compute cumulative percents in reverse order and enter in a column next to the cumulative percents first determined. Then any entry of the "less than" cumulative percentage column when added to the entry of the "more than" cumulative percentage column which is diagonally opposite the former and toward the zero-end of the second distribution will always add up to 100.00 percent.

initial checking of the reciprocal in addition to affording an extremely quick method of establishing the decimal point, insures that the cumulative percents will come out either to 100.00 or to any other desired decimal accuracy.

In plotting cumulative distribution curves, or ogives, the cumulative percents are the only ones desired and consequently the simple percents need not be computed in this case.

TABLE 1. ILLUSTRATION OF THE METHOD OF DETERMINING PERCENTS THROUGH THE MEDIUM OF CUMULATIVE PERCENTS

Class (1)	Frequency (2)	Cumulative Frequency (3)	Cumulative Percent (4)	Simple Percent (5)
34–35	1	81	100.0	1.2
32–33	1	80	98.8	1.3
30–31	2	79	97.5	2.4
28–29	3	77	95.1	3.7
26–27	5	74	91.4	6.2
24–25	5	69	85.2	6.2
22–23	8	64	79.0	9.9
20–21	12	56	69.1	14.8
18–19	13	44	54.3	16.0
16–17	11	31	38.3	13.6
14–15	9	20	24.7	11.1
12–13	6	11	13.6	7.4
10–11	2	5	6.2	2.5
8– 9	2	3	3.7	2.5
6– 7	1	1	1.2	1.2
Total	81			
Total percent				100.0

$$\text{Reciprocal of } N = \frac{1}{81} = .12345679.$$

Column 3 entries are found thus:

$1 = 1$
$1 + 2 = 3$
$1 + 2 + 2 = 5$
$1 + 2 + 2 + 6 = 11$; etc.

Column 4 entries are found thus:

$\frac{1}{81} = 1.2$ percent

$\frac{3}{81} = 3.7$ percent

$\frac{5}{81} = 6.2$ percent

$\frac{11}{81} = 13.6$ percent; etc.

Column 5 entries are found thus:

$1.2 - 0.0 = 1.2$ percent
$3.7 - 1.2 = 2.5$ percent
$6.2 - 3.7 = 2.5$ percent
$13.6 - 6.2 = 7.4$ percent; etc.

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